The DRAFTSMAN.

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THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

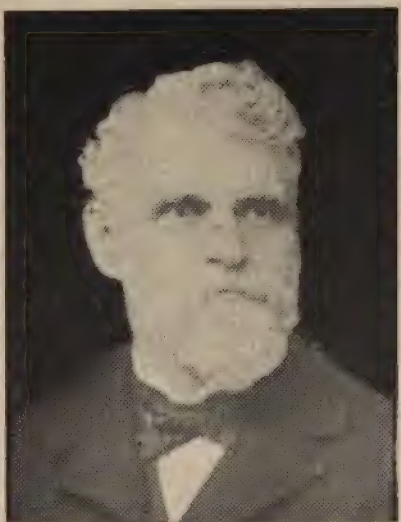
PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Mr. Ambrose Swasey, the New President of the A. S. M. E.

Honord here and wears a Cross of Legion of Honor.

MR. Ambrose Swasey of Cleveland was recently elected president of the American Society of Mechanical Engineers at their New York meeting.

Since the society is one of the leading organizations of its kind in the world, embracing the foremost engineers of this country it is deemed an honor to be at its head and Mr Swasey is the second Cleveland man to attain it in the past two years,



Mr. Swasey's predecessors in the chair of president have been such men as Admiral Melville of the United States Navy, and the late Prof. Thusrton of Cornell University.

Mr. Swasey is a member of the well known firm of Warner & Swasey Company and is recognized in the United States and Europe as the most eminent authority on the telescope and sidereal astronomy.

He designed and build both the Lick and the Yerkes telescopes and his firm has constructed most of the great telescopes of this country and Europe in the last twenty years.

The firm is also well known as machine tool builders, of lathes mainly.

In 1901, Mr. Swasey was decorated with the cross of the Legion of Honor by the president of France, being one of the few men in the United States to be so honored.

MECHANICAL.

Dimensioning Drawings,

THE angle of the dimension line has much to do with the arrangement of the figures, but in all cases the figures should be placed so to read from the right and bottom sides of the drawing.

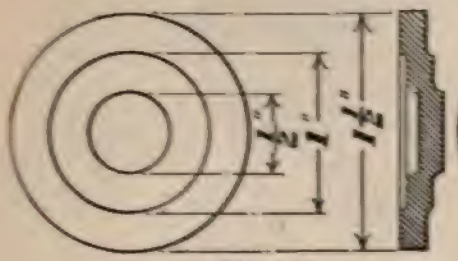


Fig. 3.

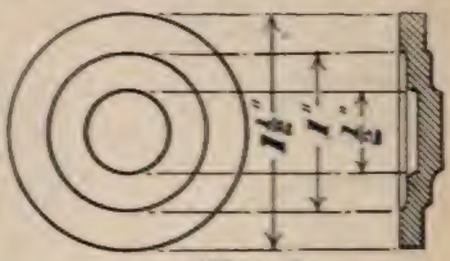


Fig. 4.

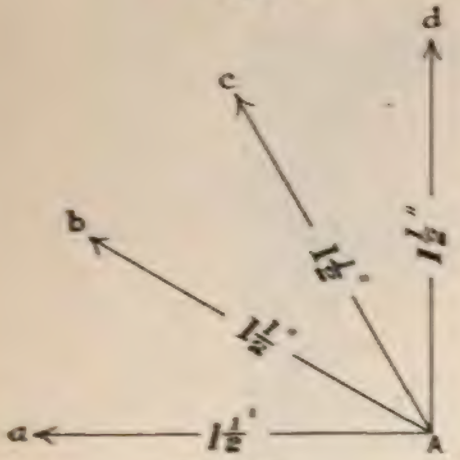


Fig. 1.

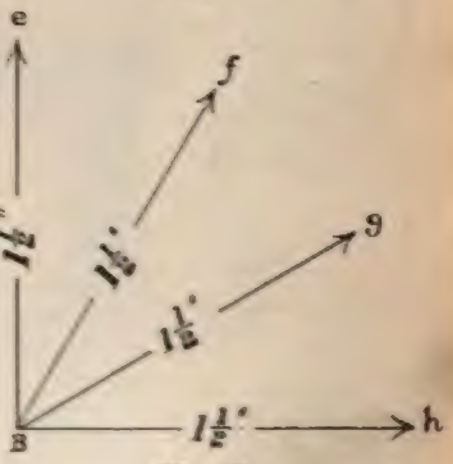


Fig. 2.

In Fig. 1, a lot of lines are drawn in to illustrate the effect of angularity of the figures, although that one on line *Ad* has been reversed.

In Fig. 2, the figures are read much more easily, and if the figures were placed as on line *Bh*, they would finally be vertical on line *Bc* instead of as shown.

It would probably be best to place the figures on *Ac* the same as *Ad* as it would be more easily read than as it is now, even if the sheet was not turned from right to left, as is often done in reading a drawing.

Then figures on lines that run and to the left at a greater angle than 30° should be turned the same as on *Ad*, so as to read from the right side. Figures should not be set to one side of

the dimension line, but a space allowed in the line for them, for the figure is what the workman wants, not the line.

Dimension lines are often carried across the projection lines, as in Fig. 4; this is a poor way, the neater form being shown in Fig. 3.

Very little thought is given to these matters by many draftsmen, and it is to be regretted, too, though there may be an extreme in such things, that is, carrying it too far and wasting time trying to be artistic.

Projecting Curves in Drawing.

THERE is often a doubt in the mind of the draftsman as to what points should be projected from view to view on a drawing, and sometimes one finds a circle or other line put in to show something which readily does not exist in the other view.

To illustrate, in Fig. 1, we have two views of a cast iron washer with the front view showing two curves intersecting, and the question is should there be a circle in the top view to show their intersection?

The front view in Fig. 2 shows the curves coming together different than in Fig. 1, the line of centers of the curves being at right angles to the projecting lines to the *top* view.

If we project the point of tangency in Fig. 1, it would be perpendicular to *CC*, but this would not be parallel to the projection lines of the views, hence could not touch the top view in the part where the curve really exists.

Again, there would be no horizontal line in the front view from points of tangency, as shown in Fig. 2, for here we have two curves intersecting at a point in their center line, which is perpendicular to the horizontal lines of the object. Then there would be no line in the top view to show point *a*, but there would be a horizontal line as shown.

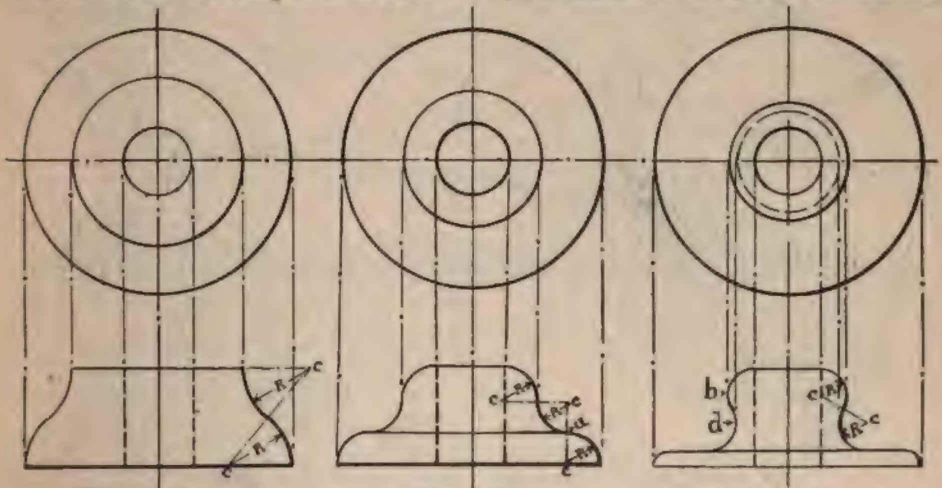


Fig. 1. Fig. 2. Fig. 3.

The next case is illustrated in Fig. 3; two curves, one under cutting so that their point of tangency cannot be projected any more than in Fig. 1.

Here the under cut surface would have to be located in the top view as any limiting point in a surface should be, and in this case it will show dotted in that view.

Only the part of the curves b and a would be shown, also a horizontal

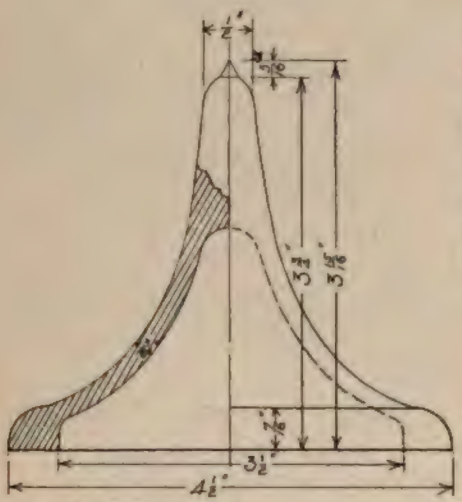
line is put in the front view.

Then the intersection of curves in the front view are projected to the top if the line of centers is perpendicular to the projection lines of the object.

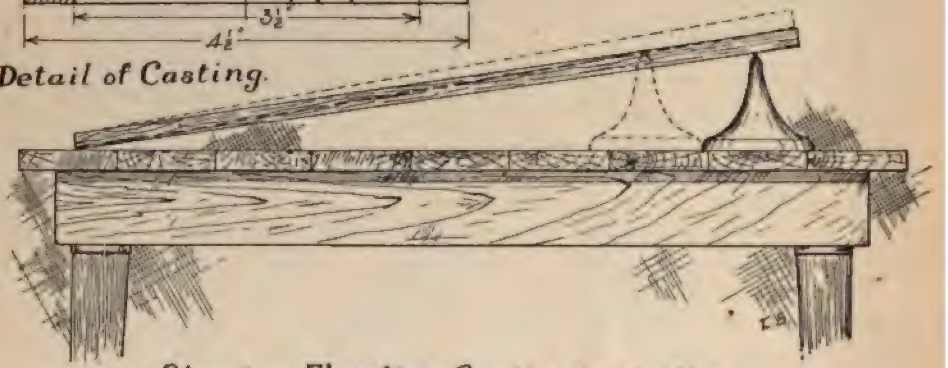
Drafting Board Elevating Casting.

To those who use flat drawing tables, the casting illustrated in the accompanying sketch will be found very useful. By placing two or more castings under the boards at the rear almost any angle may be obtained. The point may be ground up sharp, thus giving the holder a firm grip on the board.

ARTHUR B. BABBITT,
Hartford Public High School,
Hartford, Conn.



Detail of Casting.



Showing Elevating Casting in position.

"Sold by the Shock."

A farmer went on a visit to a friend. After dinner the husbandman requested to be shown round the town.

After visiting several places they finally reached the electric lighting works.

"What d'ye call this place, Dan?" queried the farmer.

"This is called the electric plant," was the reply.

"Plant! What do they grow?"

"They grow currents."

"How do they sell 'em—by the bushel?"

"They don't sell 'em by the bushel; they sell 'em by the shock."—Stray Stories.

The Use of Fillets.

BY R. T. STROHM.

THERE are numerous, almost innumerable, instances in the designing of machinery where a change of contour or of size forms an angle in the work, and, wherever it is possible to do so, a generous fillet should be used. That is, instead of allowing sharp corners or angles in castings or in machine work where a sudden increase in diameter forms a shoulder, the angle should be filled in, or rounded so as to make a gradual blending of one surface into the other.

This rounding of angles serves a double purpose. First, it improves the appearance of the piece, and hence it is to be commended, when viewed from an artistic standpoint. But what is of more consequence to the designer, the builder, and the user, it makes the piece considerably stronger and less liable to injury than if it were left with a sharp angle at the junction of the surfaces.

Fig. 1.

Fig. 2.

Anyone who has ever observed a blacksmith at work has doubtless noted the method he pursues in cutting off a piece of bar iron. He simply heats it to a red heat at the point where it is to be cut, nicks it on the hardie, quenches it quickly and lays it on the anvil so that the nick comes directly above the edge of the anvil. A light blow on the projecting end is sufficient to break the piece, along the line of the nick.

It is true that the bar has been weakened on account of the depth of the nick, since the area of cross-section of the bar at that point is decreased. Yet, if a plain bar of the same sectional area as the section at the nick had been similarly heated and quenched, it would not have broken under repeated blows, but would have simply bent over at an angle. The conclusion arrived at, therefore, is that the angle formed by the hardie has caused an element of weakness in the bar.

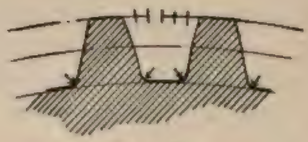


Fig. 3.

The same reasoning holds true in all similar cases, and the conclusions may be corroborated and strengthened in a number of ways. Let two bars of the same material, say steel, be turned accurately so as to form test pieces, as in Figs. 1 and 2. Let the first be cut with an angular groove, so that the diameter at the bottom of the cut is one inch. Let the other be made with a rounded groove of the same depth as the angular groove in the first bar, and let the bars be exactly

alike, in form and dimensions, in all other respects. Theoretically, since the bars are of the same material, and homogeneous, and since they have exactly the same area of cross-section at their weakest points, they should sustain the same load. But if they are subjected to stress in a testing machine, it will be found that the second, shown in Fig. 2, is by far the stronger of the two.

A very ordinary illustration of this is to be found in the case of a common threaded bolt subject to tension. Theoretically, to withstand a given load, the weakest section, or the section at the root of the thread, would need to be of an area equal to the total load on the bolt divided by the safe tensile strength, per square inch, of the material. In actual work, however, the root area must be somewhat larger than this; or, in other words, a smaller value of the safe fibre stress must be taken. For, the metal at the root of the thread is weakened by the crushing effect of the point of the thread-cutting tool, in forming the thread; and further than that, the sharp angle at which the thread surfaces meet constitutes an added cause of weakness.

Fig. 4.

It makes no diference whether the piece is to be subjected to steady or to sudden tensile or transverse stresses. The use of a fillet at the angle will make it considerably stronger, and, within reasonabel limits, the more generous the fillet the greater the strength of the part at that point. A few examples of cases in which the fillet is of great value may be cited.

The teeth of gear wheels, especially of large cast gears, are frequently subjected to great shocks in operation. At its best cast iron is not very strong when in tension or flexure. Consequently, to insure strength and freedom from breakage, the teeth are joined to the rim of the gear wheel by fillets, the radius of which is usually made equal to one-sixth the width of the space between two adjacent teeth, measured at the circumference of the addendum circle, as shown in Fig. 3.

Fig. 5.

The crank shafts of steam engines are also liable to be subjected to shocks and must sustain a considerable bending moment also. When the crank is forged, as illustrated in Fig. 4, the crank-pin is given fillets at *a*, *a*, where it joins the cranks, to prevent any possibility of cracks starting at those points, due to the bending and twisting, a thing which might easily occur if a sharp corner were used instead. The same is true of the junction of the cranks and the shaft.

The journals of railway car axles and similar axles on street cars are subject to repeated shocks under transverse stresses, and we find them con-

structed as in Fig. 5, with good fillets at the shoulders. And so the number and diversity of illustrations might be indefinitely multiplied.

The methods of obtaining the fillet are various. Formerly the corner was rounded by cutting the material of the pattern, in making patterns for castings, or by using beeswax, which can be easily molded or pressed into the desired shape. Of late, however, fillets of wood, leather and metal have been manufactured and extensively used. The wooden fillets are simply strips of wood, square or triangular in cross-section, which are glued into angles between surfaces and then hollowed out to the proper curvature. Obviously, the wooden strip cannot be easily applied to any other than plane surfaces. The leather and the metal fillets, however, which are put up in bundles of strips, each strip being four feet long, may be readily fixed to irregular surfaces of almost any degree of curvature. The leather fillet is glued in place and is sold in various sizes, according to the radius of the fillet required. The metal fillet is held in place by small nails or tongues, and is answers its purpose well. But it has the disadvantage that rough usage of the pattern may cause it to jar loose from its fastenings.

Mine Ventilation, Past and Present.

BY CHAS. KUDERER, MONONGAHELA, PA.

THE subject of mine ventilation is a matter of growing and vital importance. Mining operations have to-day developed into such a wonderful magnitude that the problem now confronting us is the proper means by which mines can be ventilated. In the earlier days of mining operation four to five thousand cubic feet of air circulated through the workings of a mine was considered sufficient. At the present day many of our mines require a circulation of from 45,000 to 65,000 cubic feet of fresh air per minute. This great volume of air must be generated from the atmosphere by powerful positive acting centrifugal ventilators.

The earliest type of mine ventilator was known as the wind cowl, by which the pressure of the wind at the surface was brought to bear effectively upon the mine air-ways by the action of a cowl whose mouth could be turned toward the wind. This was naturally very unreliable. The waterfall was also extensively applied at one time, but its application could only be made where there was a reliable source of water supply and where the drainage of the mine could be effected through a tunnel, or where the mine opening could be placed in connection with the waterfall outside the mine. Where these conditions are obtained, as is the case in some mountainous districts, the waterfall is still in use, as it is an effective means of ventilation and economical. Its application, however, is limited to the ventilation of small mines.

The foregoing methods of ventilation eventually give way to furnace ventilators. The furnace being placed

at the bottom of the up-cast shaft where attended and continually fired by fuel furnished from the pit, the heat issuing from the furnace ascending into the up-cast shaft, thus heating the air therein, causing a difference in weight between equal volumes of air between the up-cast and down-cast shafts. This method, though effective in ventilation, was dangerous and at times unreliable. In case of mine explosions the furnace being placed at great depths in the bottom of the mine, would become useless and dangerous, setting fire to the mine. As mining operations have progressed step by step, better and more positive methods of mine ventilation became necessary to supply the demand of the present age of modern mining engineering.

The foregoing methods are to-day only examples for comparison and are surpassed by modern mechanical force of exhaust steel mine ventilators. A large number of mechanical mine ventilators are patented and applied to mine ventilation with more or less success, commencing with the Nasmyth ventilator as early as 1847, to the improved type of ventilator of the present day. During all these years of experience with mechanical ventilators we have developed into distinct classes as follows:

Class 1—*Open Running Ventilators.*

Discharging air from the wheel around the entire circumference directly into the atmosphere.

Class 2—*Closed Running Ventilators.*

The wheels revolving in a closed casing and discharging the air through an open discharge orifice.

Class 3—*Force Fans.*

Taking the fresh air from the atmosphere and forcing it by compression into the down shaft through the workings of the mine and out into the atmosphere through the up-cast.

Class 4—*Exhaust Fans.*

Exhausting foul air from the mine by vacuum, the fresh air entering the mine through the down-cast, passing through the workings of the mine and finally exhausting into the atmosphere through the up-cast.

Class 5—*Centrifugal Ventilators.*

Having blades or vanes set at right angles to the plane of rotation of the wheel; the air as it enters the wheel through the intakes passes through the wheel and is then discharged at the tips of blades by centrifugal force.

The most modern and highly efficient ventilators of the present day have the following principles embodied in their construction:

1—Double intake ventilator.

2—Closed spiral casing.

3—Deflecting center cone.

4—Blades or vanes radiating from the tips inward toward center of wheel a proper distance, then diverging into a curve tangent to the throat circle.

5—Reversible force or exhaust.

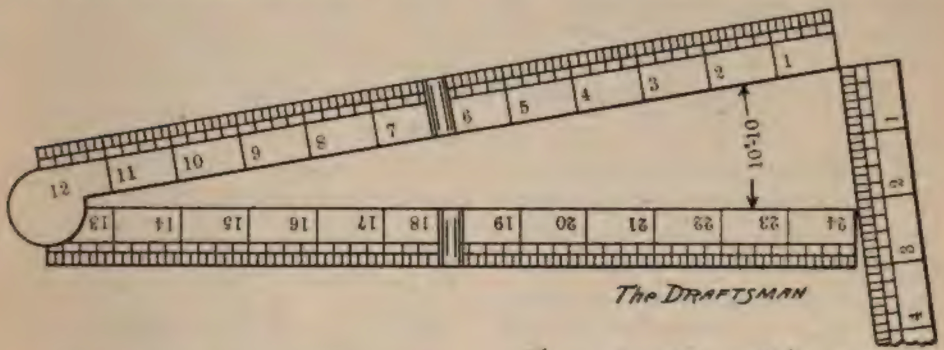
6—Impelling intake fans such as have flat surfaces set at angles to axis of shaft impelling the air as it passes through the intakes.

The Measurement of Angles by the Opening of a Two-foot Rule.

BY P. ENDRIVER

IT OFTEN happens that the draftsman or mechanic desires to lay out a given angle, or to measure an unknown angle, and no protractor is at hand.

In such a case the measurement may be made very approximately by the use of an ordinary two-foot rule as shown in the accompanying sketch. The table herewith gives the angle of openings up to 90 degrees and for measurements by 8ths up to 17 inches, the opening nearest to 90 degrees.



For any angle not given the opening may be determined by the following formula:

Opening=24×Sin ½ angle and conversely,

$$\text{Sin } \tfrac{1}{2} \text{ angle} = \frac{\text{Opening}}{24}$$

As an example of the application of this formula we will suppose we wish to lay out an angle of 40 degrees

Then: Opening=24×Sin 20°

Opening=24×.3420

Opening=8.208 inches

Having an opening of 15⅜ inches, required, the angle

$$\text{Sin } \tfrac{1}{2} \text{ angle} = \frac{15.375}{24}$$

Sin ½ angle=.6406

½ angle=39°—50′

Angle=2×39°—50′

Angle= 79°—10′.

Table of Angles Corresponding t Openings of a Two-foot Rule.

In.	Deg's.	Min.	In.	Deg's.	Min.
⅛			4⅜	21	00
¼	1	12	4½	21	37
⅜	1	48	4⅝	22	13
½	2	24	4¾	22	50
⅝	3	00	4⅞	23	27
¾	3	36	5	24	03
⅞	4	11	5⅛	24	39
1	4	47	5¼	25	16
1⅛	5	23	5⅜	25	53
1¼	5	58	5½	26	30
1⅜	6	34	5⅝	27	07
1½	7	10	5¾	27	44
1⅝	7	46	5⅞	28	21
1¾	8	22	6	28	58
1⅞	8	58	6⅛	29	35
2	9	34	6¼	30	11
2⅛	10	10	6⅜	30	49
2¼	10	46	6½	31	26
2⅜	11	22	6⅝	32	03
2½	11	58	6¾	32	40
2⅝	12	34	6⅞	33	17
2¾	13	10	7	33	54
2⅞	13	46	7⅛	34	33

3	14	22	7¼	35	10	10⅛	49	54	14⅜	73	36
3⅛	14	58	7⅜	35	47	10¼	50	34	14½	74	21
3¼	15	34	7½	36	25	10⅜	51	13	14⅝	75	06
3⅜	16	10	7⅝	37	03	10½	51	53	14¾	75	51
3½	16	46	7¾	37	41	10⅝	52	33	14⅞	76	36
3⅝	17	22	7⅞	38	19	10¾	53	13	15	77	22
3¾	17	59	8	38	57	10⅞	53	53	15⅛	78	08
3⅞	18	35	8⅛	39	35	11	54	34	15¼	78	54
4	19	12	8¼	40	13	11⅛	55	14	15⅜	79	40
4⅛	19	48	8⅜	40	51	11¼	55	55	15½	80	27
4¼	20	24	8½	41	29	11⅜	56	35	15⅝	81	14
8⅝	42	07	12⅞	64	53	11½	57	16	15¾	82	02
8¾	42	46	13	65	35	11⅝	57	57	15⅞	82	49
8⅞	43	24	13⅛	66	18	11¾	58	38	16	83	37
9	44	03	13¼	67	01	11⅞	59	19	16⅛	84	26
9⅛	44	42	13⅜	67	44	12	60	00	16¼	85	14
9¼	45	21	13½	68	28	12⅛	60	41	16⅜	86	03
9⅜	45	59	13⅝	69	12	12¼	61	23	16½	86	52
9½	46	38	13¾	69	55	12⅜	62	05	16⅝	87	41
9⅝	47	17	13⅞	70	38	12½	62	47	16¾	88	31
9¾	47	56	14	71	22	12⅝	63	28	16⅞	89	21
9⅞	48	35	14⅛	72	06	12¾	64	11	17	90	12
10	49	15	14¼	72	51						

The Valuable Man in the Shop.

BY GEORGE E. WALSH.

THE modern shop is essentially different from that of a quarter of a century ago, and the tendency to manufacture as cheaply as possible by means of machinery is rapidly abolishing hand work, and the workmen are becoming more and more limited specialists. The modern complicated machines require skilled operators to run them, but their construction and repair are more important from the point of view of the shop workers. There is a good deal of detail work that must be performed by very accurate hands and eyes. No machinery can do this, and unless the workmen are skilled in handling the file, scraper, cold chisel and hammer difficulties must follow.

The young men learning the trades to-day are in danger of overlooking the necessity of becoming intimately acquainted with the handling of all sorts of tools. In the old shops a journeyman or apprentice had to be a good deal of "a jack of all trades." He learned every feature of the business. He probably had to solve more knotty problems in the course of a year than the workmen of to-day would stumble across in ten years. In learning the trade to-day the apprentice in a machine shop depends so much upon machinery to do the accurate detail work that he fails to get the all-round skill and education that makes him a most valuable man in the future. The machinist or tool maker who can do accurate hand work is becoming a rarer product of our schools and shops each year. The modern tendency is not to teach him to handle chisel and file to finish off with almost the accuracy of a machine the little jobs that were formerly a part of the regular shop practice.

Yet the valuable man of the future shops must of necessity be one who has had this drill, and who, instead of abandoning good hand work because machinery has come to his aid, keeps

up the old-time practice for the love of it. The complicated machinery of to-day will soon require expert hand workers. In the repair shop this will be particularly true. The call from many of the large railroad repair shops in the past few years has been for men of this character. The old-time shopmen who were taught their trade so thoroughly are the most in demand. The very familiarity they have had with the tools of common use has made them self-reliant. They have learned to solve knotty problems which the modern worker is apt to approach with misgivings. The imagination after all plays a part in shop work. It requires one to see through the imagination that some possible trouble in the machinery is causing the breakdown. The man without any imagination or training to look for the trouble in the most likely place is apt to find himself helpless before a job which another could easily solve.

It is not true that all shops turn out apprentices and journeymen of this character. Some of the modern ones drill their workmen in all the detail hand work that will help to make them of value. The men must spend some of their time at the vise with file and hammer for hours at a stretch. They are not finished workmen until they can do as fine a piece of labor with file or hammer as machinery could do. The man who can go down in the wheel-pit with chisel and hammer, and by the light of a tallow candle chip a keyway in a jack shaft is worth more in an emergency than a dozen who know nothing about such kind of work. The average workmen of to-day dislike to chip away a slot on some line of shafting where there is scarcely room to swing a hammer. But such work must be done at times, and no shop can get along without men who can do it.

The man who can do useful hand jobs around a shop is thus one of the most valuable and indispensable to-day. Even if machinery has displaced much of the work that was formerly done by hand, we cannot afford to neglect this side of the shop life. The modern technical schools have heretofore proved accurate in their theoretical teaching, but this sort of education must be supplemented by the practical side. Some of them are revising their practice in appreciation of this. Instead of simply teaching the students how to handle the labor-saving machinery and acquainting them with the different kinds of tools and modern inventions, they are compelling them to take off their coats and swing the hammer, push the file and use the scraper. Unless they can do good hand jobs first, they are not considered proficient enough to go up to the higher work. This is needful for the complete education of the modern shop workers of all kinds. Employers are demanding that they shall understand the rudiments of their trade as well as the higher parts of it.

One of the most useful experiences for a young man in the shop is to be put to the repairing of intricate machinery. The problem must first be solved. This question must appeal to him: Is is possible to make the repair without taking the machinery apart and shipping the broken part to some distant shop for repair? Every hour that the machine is out of order a big bill is running up against the owner. It may be that the trouble develops in the busy season, and the machinery will lose hundreds of dollars a day to the owner. The man who can go down into the machinery and with a little ingenuity repair it—even if it is only temporarily until some new parts can be ordered—is worth more to his employer than his wages would amount to in a year.

It is not possible for a young journeyman or apprentice to do this without considerable experience and a training which makes him self-reliant and ingenious. If his shop practice has been limited to the simple work of manipulating machines and doing all kinds of work with labor-saving tools, he will not be of much use in an emer-

gency. He lacks the skill and training which is the best background for a shop or theoretical education.

The high-priced men in all the trades are those who are called upon to do the unusual things, and who can be trusted to accomplish the results desired. The trades are full of young and old men who can do ordinary skilled work in an ordinary way; but there are few in our shops who can accomplish the unusual. In no department of work are there more unusual jobs turning up than in mechanics, machinery, and the repairing department of the large mills and factories. To meet these calls the worker must be something more than ordinary. The training for the work must be thorough, and from the ground up. Fortunate indeed is one if he is brought up in a shop where the foreman is one who appreciates the practical value of old-fashioned as well as modern training.

Recently it was found necessary by a prominent railroad to send a crew of workmen to repair a wrecked traveling car, which the company used for emergencies along the line of their travel. When the workmen reached the place of trouble, they found themselves a thousand miles away from any repair shop of the company. The wreck had been more disastrous than they supposed. The men did not have all the tools they were accustomed to work with. It looked for a time as if the traffic of the road would have to be held up indefinitely until the proper tools could be sent for. This would cost the road hundreds of dollars, and completely interrupt traffic along the whole system. The assistant foreman of the crew was an old-time shop-trained workman, and while the "new" men were giving up the job until they could get the necessary tools he started a temporary blacksmith shop and forge on the place, and within a few hours had shaped and prepared crude, but effective, tools to work with. In less than half a day the men were able to begin operations and the wreck was removed.

The workmen today are not permitted in shops to go beyond the draftsman's designs. These designs are supposed to be executed with all care, and they are absolutely correct, according to mathematical measurements and drawings, and the workmen are supposed to follow them implicitly. This habit has resulted a good deal in the training of workmen to depend entirely upon design and certain machine tools. They do nothing of their own initiative. They become slaves to a necessary condition that in time destroys original workmanship. The drawing is official, and supreme, and the workman who fails to follow it must be held responsible for errors. It is sometimes a question whether the workman should not study something more than the mere work of following and executing designs. Many a piece of work could be saved if the workmen understood something more than the dull routine of cutting according to line. It hurts no man to make a study of a design so that he has an intelligent appreciation of its meaning. The danger of interfering with its execution through a self-important knowledge, which leads some to assume they know it all, is offset by the fact that the most intelligent workmen always do better work, and accomplish more in the end in nearly every shop. When a man takes an interest in a piece of work he is sure to accomplish more than another who cuts according to line with no interest whatever in what he is doing.

There is a middle ground where the workmen in the shop and the draftsmen should meet. Without assuming to trench upon each other's field, they should have sufficient knowledge of each other's duties to be able to appreciate their difficulties and shortcomings. The draftsman's training is not complete until he knows something of the work that the men in the shop are called upon to do in executing his designs, for this knowledge will often enable him to save time and money for

his employers. The drafting-room labor is necessarily high-priced, but its cost is more largely determined by the ability of the draftsman than anything else. A high-salaried draftsman is often the cheapest in the end. His work is not only surer and truer, but he knows how to design so that the least amount of labor and material will be required to execute the drawing when turned over to the workmen in the shop. This indirect saving may appear sometimes to employers as of a negligible quantity, but it is not so in large shops. It amounts to the cost of more than the salaries of several draftsmen in the long run.

No draftsman can do this sort of work satisfactorily unless he has a good working knowledge of the shop methods observed, and of the men and tools employed. He must know that his drawings are for the purpose of absolutely guiding the men, and that they must first be perfect in every line. There is no guess-work, or loopholes for errors. Positiveness of detail lines must be a part of his stock in trade. A familiarity with shop practice brings him in closer touch with his work, and he is enabled to design with more freedom, and with a surer knowledge that he will save money to his employers.

Now in the same way the workmen in the shop who knows something of the draftsman's art and skill will be able to appreciate better the requirements of his own trade. A healthy interest taken in his work will be stimulated. He will learn to appreciate a good piece of draftsmanship, and to recognize a poor and clumsily drawn one. In the latter he will naturally look for mistakes, and probably be on his guard so that in the end he may save costly mistakes to the firm.

It is not advocated that shop workers should take a course in draftsmanship—although this would not hurt them—but it is recommended that they should make a more thorough and complete study of the different lines of work touching upon their specialty. They require, first, a good training in all the different uses of tools, and then a knowledge how to manipulate the ordinary ones that are being discarded in many shops through the invention of machinery. They should know how to repair and keep in order the tools and machines intrusted to them. Second, they should take such a lively interest in their work that they cannot rest content until they know something about designing and the work of drafting as it is carried on in the best shops. This knowledge can be acquired with a little extra study and work in almost any shop, or at least from books or papers at home. Third, the ambitious workman in the shop should make it a study to improve his mind and invention by experiments with machinery and tools. Place a few problems before the mind, and work them out on paper. What would one do if this or that part of an intricate machine should break or get out of order? If a steam engine or electrical dynamo should suddenly stop running without any apparent cause where would one look for the trouble? It is possible for one to put such questions before the mind for solution so that in time he would be prepared for many emergencies in the shop or mill.

The modern tendency to specialism hurts the individual if he is content to master simply the details of his own chosen line. If he cannot carry his enthusiasm and interest in his work beyond his own immediate field of operation he cannot prove the valuable man of the shop which every foreman and employer are constantly on the lookout for. He must prove his worth by his studies and efforts. Some workmen wtihout any theoretical knowledge of other fields of work will show such interest in their endeavors that they will pick up in the shop by actual experience a complete working knowledge of other specialties that bear directly or indirectly upon theirs. They find that this extended experience always helps. It helps them to do their work more intelligently, and some day there comes an opportunity to prove their value as

a man of ideas and reliance.

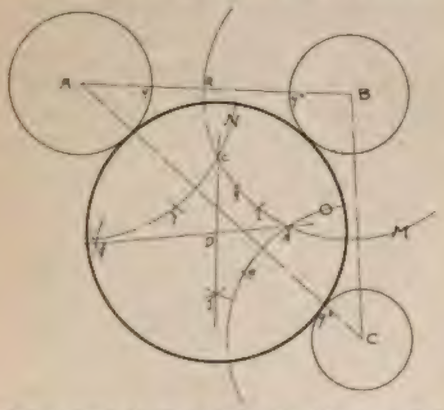
It should be assumed that every workman in a shop is ambitious to better his condition, and to make his services of more worth to himself and his employer. This is particularly true of the young workman. He can accomplish this only along the lines suggested. He must make his work perfect, so far as human skill can do it, and then show a mind broad enough to grasp something more than the details of his daily routine jobs. He may wait years before this acquired skill comes into use, but if he waits half a life time the pleasure derived from knowing is worth all the effort. American shop workers are the most intelligent in the world; but there is still room for advancement. Otherwise the American youth would be robbed of the natural incentive to do better work than his companions, which is the zest and life of existence.

To Describe a Circle Tancent to three given Circles.

H. MACDONALD.

I SEND you this geometrical construction; it is one which I came across in gearing.

I have never seen it in any geometry or book of geometrical construc-



tions, and it is original with me, for I worked many hours to get it.

I have given it to many engineers, draftsmen and students, none of whom could work it out.

PROBLEM.—To describe a circle tangent to three given circles whose diameters are different.

SOLUTION.—Let *A*, *B* and *C* be the centers of the three given circles, whose diameters are different. With *B* as a center and a radius of about one half the distance *AB*, strike the arc *M*. With *A* as a center and a radius of *Ay* plus the distance *ay'*, strike the arc *N*, cutting are *M* at *c*.

With C as a center and a radius of Cy' plus the distance ay', strike the arc *O*, cutting arc *M* at *d*.

Bisect angle *cdg* to get point *f* and draw line *fd*.

Bisect angle *hci* to get point *j* and draw line *cj*.

The intersection of lines *fd* and *cj* is point *D*, which is the center of the required circle.

Forged Steel Flanges.

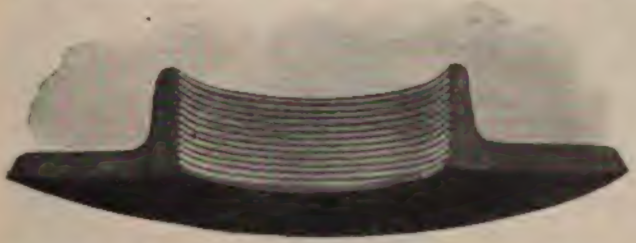
LIKE everything else a boiler is apt to be judged by the first impression its appearance creates.

A boiler or tank with neatly calked seams, well set rivets and sightly flanges finds ready favor with the customer, where the slighting of these details in a boiler or tank equally good or strong might lead to its rejection.

Purchasers of boilers will testify that altogether too large a percentage of cast flanges crack during shipment or setting of boilers, and any experienced boilermaker will also say that

on an average one cast flange in ten crack when the last rivet is put in, in securing it to the boiler.

A reinforcement of the hole must



be made so that in the case of a pipe the threads may be of a number to insure a tight joint, so a piece of boiler plate is often shaped and riveted on.

"Pressed" flanges made from boiler plate are weakest where the strain is greatest—at the foot of the hub, because in pressing the flanges the metal is drawn thinnest at the right angle turn. Worse still in the pressed flange it is possible to cut only three

or four full threads, owing to the widening of the inside diameter due to the sweep or curve that is an unavoidable defect of every pressed flange and which leaves a "hatching place" for rust and scale.

With the improved type of flanges, the Ryerson Forged Steel Flanges—a full deep thread running flush with

bottom is obtained, due to the extra high neck.

A square sharp corner at the base of the thread is also secured and the danger of corrosion of flange and shell that takes place under the dead portion of a pressed steel plate flange is avoided.

The Ryerson Flange is made of homogeneous soft steel of 60,000 lbs. tensile strength, tough enough to withstand the greatest strain, but sufficiently elastic to conform to any slight inequality of the shell.

A comparison of the forged and cast flanges is made in the following table.

——TABLE——

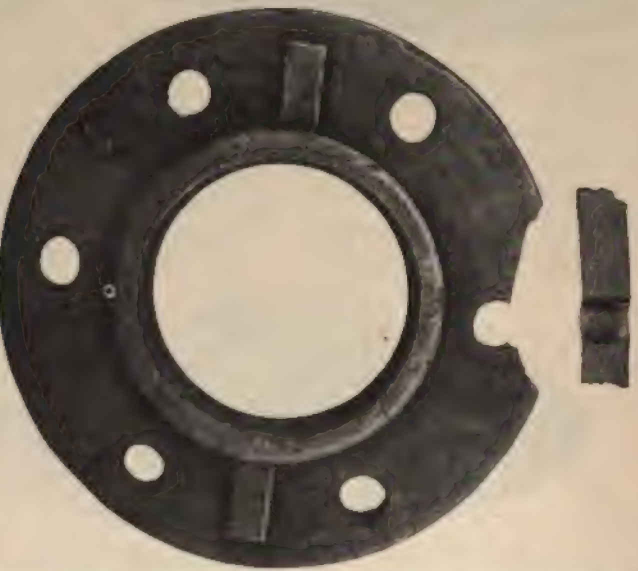
Size Pipe Inches	Diameter Inches	Thickness Inches	Equivalent To Cast Iron Inches
¾ inch	6 inch	5/16 inch	1½ inch
1	6	5/16	1½
1¼	6½	5/16	1½
1½	7	⅜	1½
2	8	⅜	2
2½	8½	⅜	2
3	9	⅜	2
3½	9½	7/16	2
4	10	7/16	2
4½	10¾	½	2
5	11¼	½	2
6	12½	½	2
7	14	⅝	2
8	15	⅝	2¼
9	16	¾	2¼
10	17½	¾	2¼
12	20	13/16	2¼

Forged steel flanges may be secured either flat or bent to any sweep or shell from 18 to 72 inches, and special flanges can be made to suit requirements.

Much of the same attention will have to be given to rivet spacing for

a forged flange as for a steel plate of the same thickness.

The edges are lathe finished and beveled for calking and a tight fit easily secured.



Cast iron flanges crack easily while Forged flanges can be mashed into any shape without breaking.

NOTE—We are indebted to Josph P. Ryerson & Son, Milwaukee Ave., Chicago, Ill. for Illustrations and table.

The Correspondent Student as an Inventor.

IN all technical schools that carry on instruction by correspondence the faculty have discovered that many of the students, after they have attained an educated knowledge of their work, are very successful along the line of invention. At first thought it might seem somewhat strange that a man who, for fifteen or twenty years, has been no more than a fireman or a machinist, should suddenly branch out as an inventor. A thoughtful consideration of the conditions, however, will quickly change that view. The man has had fifteen years of practical experience in the machine shop. He knows by actual handling, day after day, the weak point in a certain machine. He cannot help thinking about it, because he is brought face to face with the machine every working day; but knowing nothing of the scientific principle upon which the machine is based, he is unable to reason out an improvement. Suppose the man takes up the study of mechanical engineering by correspondence. His background of practical experience is of inestimable value in his studies. As he goes on, he begins to see the cause of the weak point in the piece of machinery, and naturally he starts to work to overcome it. One thing leads to another, and the probabilities are that he invents some useful improvement that increases the working capacity of the machine.

In the experience of the students of the American School of Correspondence this has occurred over and over again. One pertinent example of the foregoing is the recent invention of an automatic stoker by George F. Tinkham. Tinkham was born in Middleboro, Mass., and when a boy of eleven left school and started work (his father was serving in the Civil War). At twenty he enlisted in the United States army and saw active service in several Indian campaigns in the Northwest. From then on to 1887 he worked as a fireman and assistant engineer in different plants in Iowa. The result of his experience as a fireman was the developing of an idea for increasing the capacity of boilers and consuming smoke,—an idea which, during his correspondence course, took practical form in a patent automatic smoker.

The plant in Cleveland, Ohio, of which Mr. Tinkham is now engineer, has two boilers equipped with his device. It is seldom that there is even a trace of smoke issuing from the chimneys. Moreover, careful tests have shown that his device largely increases the capacity of the plant, as the boilers, which are rated at only 146 H. P., develop by actual test 241 H. P., an increase of about 45 per cent.

Mr. Tinkham had few opportunities for obtaining an education. He ceased attending school at the age of eleven, and for thirty-seven years found little time for study. In September, 1900, he began a stationary engineering course in the American School of Correspondence. The knowledge derived from his studies has been of great practical value to him in his work. His chief regret is that he could not have had this opportunity earlier in life.

Formulae for Position of Center of Gravity of Trapezoids.

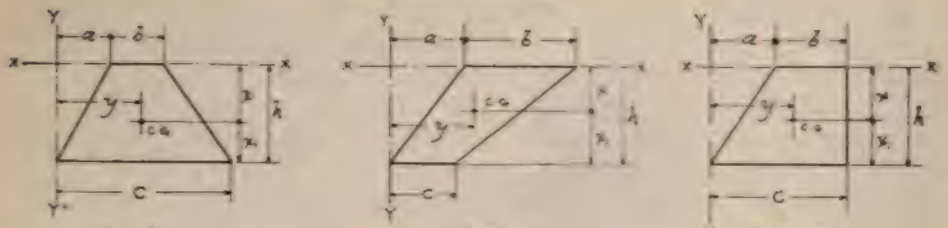


FIG 1 FIG 2 FIG 3.

$$x = \frac{h(b+2c)}{3(b+c)}$$

$$x_1 = \frac{h(2b+c)}{3(b+c)}$$

$$y = \frac{ac+2ab-bc}{3(b+c)} + \frac{b+c}{3}$$

$$\text{also} - y = \frac{ab+b^2}{3(b+c)} + \frac{a+c}{3}$$

For FIG 3 ONLY $- \; y = \frac{2c}{3} - \frac{b^2}{3(b+c)}$

Mr. F. W. Seidensticker, of Chicago, sends the above formulæ for finding the position of center of gravity for trapezoids, which may be useful to our readers.

Ideas of an Inventor.

No more striking way of handling a fortune has been discovered than Mr. Gordon McKay's bequest of $4,000,000 to Harvard colloge for science, while his sons receive $100 a year, with perhaps a little more in the future. He has thrown into relief the importance of scientific study in our day, and he has put into active practice ideas which are ostensibly held by Mr. Andrew Carnegie and other critics of wealth. In judging such bequests the general world must leave out any personal details which might contribute to the result, as it knows nothing of the family relations or the natures of the boys. The interesting question is on the principle involved. We are inclined to think that Mr. McKay's act, if it represents a principle, will seem extreme to the majority of liberal minded Americans. To have left $3,000,000 to Harvard and divided $1,000,000 among his sons would have been liberal to science, and would have given the boys a better chance in the world, if they are made of good material wisely directed. If a youth is not able to use a favorable pecuniary start to advantage, there must be something wrong in his nature, or, what is more likely, in his bringing up. The worship of the self-made man, which was rife a generation ago, has disappeared, and the principles which make it well for a boy to have money spent upon his education also make it well for him to have the advantage of some money in beginning independent life, provided he is strong enough to use it to enlarge his opportunities instead of diminishing his responsibilities. Nevertheless, although that truth can hardly be denied, the general influence of a will like Mr. McKay's is good, in as far as it raises the banner of public spirit and intellectual ardor against the too rampant spirit of private wealth.—Collier's Weekly.

Candle-Power of Incandescent Lamps.

By H. B. White.

IT MAY be interesting to the readers of this magazine to learn just how the candle-power of incandescent electric lamps is determined.

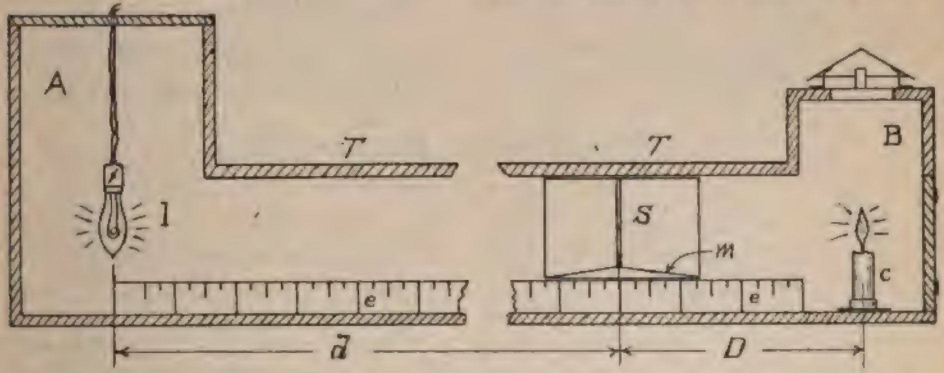
In the first place I will state that the candle power is the number of standard candles that would produce a light of equal brilliancy. A 7/8 in. spermaceti candle is considered the standard unit in general use.

The illumination of a candle at a distance of 1 ft is called a candle ft. and is considered a good light to read by.

Moonlight is equal to .025 candle ft. An instrument called a photometer is used to measure the candle-power of incandescent lamps.

There are several forms of these instruments, but they all involve the same general principle.

We will consider the one known as "Bunsen's photometer" shown in our sketch.



(A-B) represents a box having the inside walls coated with a non-reflecting paint and made in two sections as shown. (L) is the lamp to be tested, while the candle is shown at (c). The horizontal tubes (T T) project from the sides of each section of the box and are provided with a scale (e) by which means the position of the screen (s) is determined.

The screen is a small sliding frame in which is inclosed a piece of paper.

There is a spot on this paper (usually a grease spot) that is more translucent than the surrounding part. On each side of the paper is placed a small mirror (m), so inclined that the spot on the paper is visible from above through a horizontal slit in the tubes. In making the test the room is darkened and the screen is adjusted along the tube until the spot on the screen disappears. This shows that the candle light and the electric light have the same effect on the screen. If the screen was half way between the candle and the electric light they would be identical, i. e. I. C. P. but the adjustment would be quite different with a 16 C P lamp.

The following rule is the base of all calculation. The intensity of light received by an object varies inversely as the square of its distance from the source.

Thus—If a light of 16 C. P. intensity is 4 ft. from an object and is changed to a distance of 8 ft. the in-

tensity will be ¼ of 16 or 4 C. P.

Here is the formulas.

Let l=lamp to be tested.

Let d=distance from lamp tested to screen.

Let D=distance from candle to screen.

The C. P. of lamp then is $l = \dfrac{d2}{D2}$

Example: If a photometer screen shows a distance of 20″ from lamp to screen and 2″ from candle to screen what is the C. P.?

d=20″

D= 2″ then

$$l = \frac{20 \times 20}{2 \times 2} = \frac{400}{4} = 100 \text{ C. P. (ans.)}$$

or say d = 16 and D = 4 then,

$$l = \frac{16 \times 16}{4 \times 4} = \frac{256}{61} = 16 \text{ C. P. (ans.)}$$

The photometer here considered is the one mostly used in the manufacture of incandescent lamps. After the filiament is placed in lamp it is desired to know the voltage that will be proper to use for its economical operation.

It is determined by placing a lamp of known C. P. in the photometer in place of the candle. This lamp is supplied with the exact voltage to bring it to the required C. P.

The screen is placed midway between the sample lamp and the lamp tested.

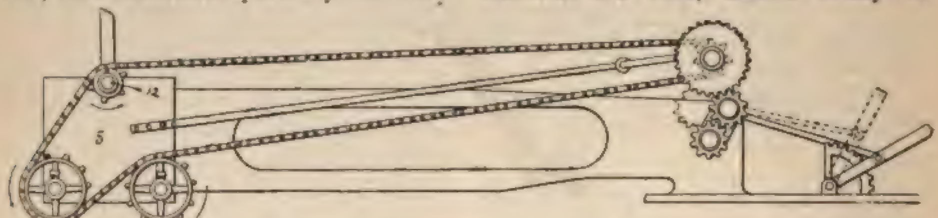
The latter is connected in series with the source of power and a rheostat while a voltmeter is in shunt circuit.

The rheostat is then adjusted to bring the light to such luminous intensity that the paper diaphragm of the screen shows equal brilliancy on entire surface.

The reading of the voltmeter will then show the proper voltage required for the lamp.

A Novel Valve Mechanism.

THE accompanying illustrations from The Practical Engineer show a very unique valve reversing mechanism for steam engines. The strongest point of the arrangement is the doing away with the usual eccentric rod, and associated parts by the substitution of rotary devices and transmitting gearing adapted to drive the valves so as to admit the steam equally to opposite ends of the cylinder alternately; and to exhaust in like manner therefrom. Thus any possibility of an unbalanced stroke is overcome and the use of cylinder cocks entirely obviated.



A further object is to provide a simple reversing mechanism, in which the elements are held, locked firmly in their adjusted position, so that the lead can be reversed by a simple movement of the lever.

The same numerals of reference denote like and corresponding parts in

.each of the several figures of drawing —5 designates the cylinder, 6 the feed chamber, to which the steam is supplied by pipe, 8 is the inlet parts, 10 is

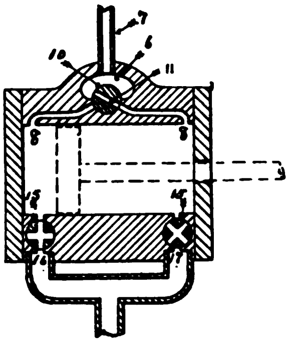


Fig. 2.

a revolvable inlet valve, having a single transverse passage, 11, 12 valve spindle, 15 stuffing box, 14 is a lead on feed chamber 6, which can be removed for purpose of taking out the valves, 15, 15, are exhaust parts, 16, 17, are exhaust valves with intersecting passages see (figure 2).

It will be seen that the valve 10 travels at half rate of the engine and valve 15, 15, at quarter rate of the engine.

It can also be made as an expansion cut-off by the size of inlet part II.

The wear on the valves will be greatly reduced by their having such slow motion, and by the way in which they are placed the back pressure will also be greatly reduced. The reverse is also so simple that it will be understood without explanation.

To Lay Out Arcs and Lines.

To Lay out a line equal to a given arc, draw the chord A—B, Fig 1. and extend it and måke B—C =1-2 A—B.

With C as a center and a radius of C—A strike line at E, then E—B is approximately equal to arc A—B.

To lay out an arc equal to a straight line, devide A—B Fig. 2. into four parts and with C as a center (CB=1-2 AB) and radius C—A strike arc at D, then B—D is approximately equal to AB.

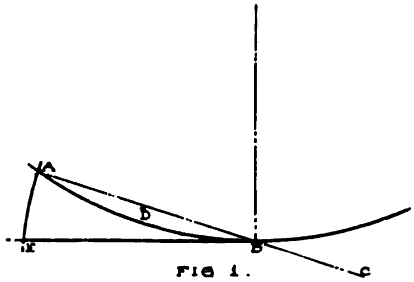


FIG 1.

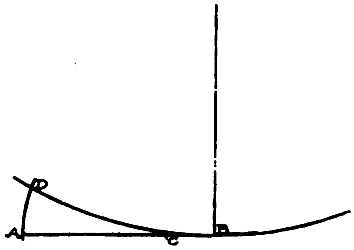


FIG. 2

ARCHITECTURAL.

The Use of the Mirror for Illuminating Dark Cornres.

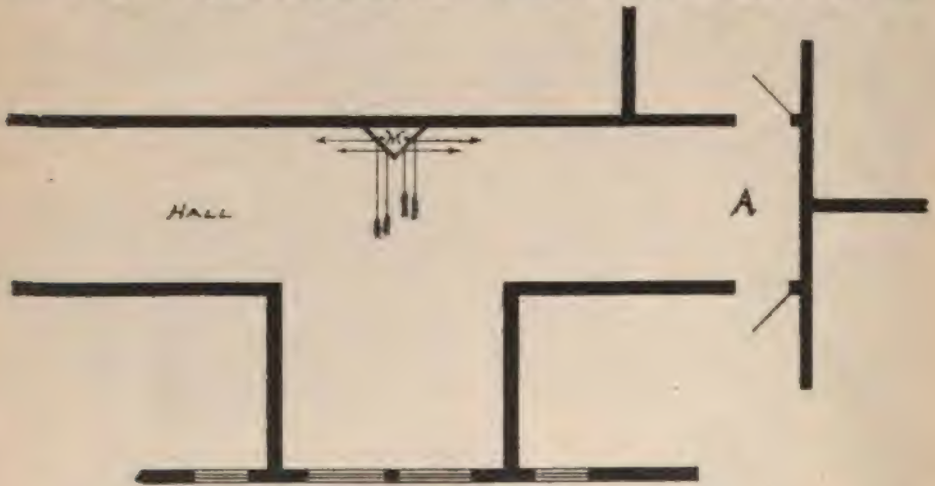
THERE are in architectural design many things that tend to worry the draftsman, and the builder, too, and one is to avoid dark corners.

To arrange all the rooms to receive outside light is quite a task and the entrance to these rooms must be made somewhere, to be sure, but not to take too much light of the rooms.

A certain apartment house has two suites of rooms entered from a center hall, but the arrangement made a dark place at the doors. Some distance down the hall was an alcove with two nice large windows on the wall opposite those windows were placed two mirrors, back to back, set at an angle, each being 45° with the wall.

It is a principle of optics that a ray of light is reflected at the same angle from the surface of a flat reflector as the angle at which it comes on, that is, the angle of *incident* is equal to the angle of *reflection*.

The light coming in at right angles to the wall is at an angle of 45° with the glass, and since it passes off at the same angle, it would be then parallel with the wall and be cast into the dark corner at *A*.



On a clear bright day, the part at *A* is well illuminated and that to the left would be much helped, too.

Mirrors 24 inches wide and 3 feet long will give fine results in a hall of 6 feet in width and 20 feet from mirror to dark spot.

Building Construction.

Continued from page 296 the December Issue.

THESE articles on forces applied to structures go a very short way, but they go far enough for the *needs* of a practical man, who, if he is curious in this direction and has a taste for mathematics, may go as much further as he likes. In my endeavor to be practical I have written from my own experience of the kind of calculations which arise in ordinary office work. The subject is a department of mechanics. I have tried to pick out, without any show of want of sequence or incompleteness, the questions which arise in building construction. The student may reasonably assume that if he studies these articles and understands them he will be prepared to deal quantitatively with any strength question, moderately determinate, likely to arise in building practice. It is surely of advantage to have the essential things selected and put in concise order. We know that the pendulum of a clock does not fulfil all the conditions of a "simple pendulum," but it keeps time with efficient accuracy for practical purposes. We know that no two separate pounds of sugar weighed out to customers by a grocer are of exactly the same weight, and that no two separately cut yards of cloth sold by a draper are of the same length, but the weights and lengths are practically correct. It is not sought to be conveyed that any carelessness of estimate or measurement is pardonable; this is not so. The test of accuracy in a clock's pendulum is that the clock will keep time; of the grocer's and draper's accuracy, that their customers reweigh and remeasure and are satisfied, and that the quantities sold agree in their totals with the quantities which the grocer and draper bought wholesale. A constructor must design safely and economically.

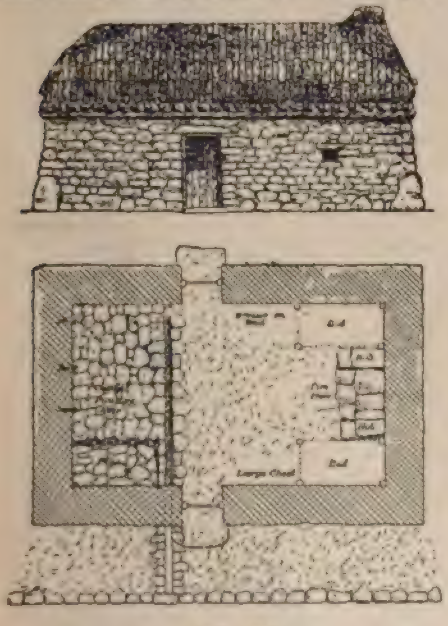


Fig. 76.

The few principles which have been illustrated and dealt with are of very frequent application in very different ways, but the student must not for a moment think that they are restricted to the cases given. For example, some of the considerations in connection with beams fixed at one end apply to a pillar to which a heavy gate is hung, or to a wall or chimney in a wind. The question of distribution of pressure between surfaces which has been considered in reference to arch voussoirs, and again the same principle in connection with the consideration of the center of pressure at cross-sections of struts, is one of very wide application. But it is not necessary to multiply instances.

These few words must not be taken as any "farewell address" to force calculations. On the contrary, the student has been introduced to principles which it is to be hoped will remain in his mind for everyday application and extension. It is to be feared that building students have not hitherto

had their attention sufficiently directed to this *funndamental* part of their work.

HOUSE BUILDING.

54. There is no human construction that does not exhibit care and carelessness, wisdom and lack of wisdom; and it is the business of the student to see both sides and to profit by what he sees. The simplest kind of house or shelter is probably the piece of bark with which the Tierra del Fuegan shields himself from the cold wind as he moves about. The Australian blackfellow sets up three pieces of bark to shelter his head and shoulders when he sleeps. We are aware that we skip a large number of terms in our advancing series when we take a Connemara cabin (Fig. 76) as our starting point for the study of house building. We are further discriminating, because our Connemara cabin is a specially good erample and we shall find admirable construction points in it. The builder of this cabin has as good grounds for pride in his work as the builder of many more pretentious houses. In judging a man's work we must take account of all the circumstances. This single-roomed house to shelter the Connemara peasant and his live-stock is what he can afford, and it must be made of such materials as he has at hand. In some places he cannot get lime within miles of his house, and so he must build with very little lime. The walls are dry-built of granite (in the house shown) and the inside is pointed and rough-plastered with mortar; when it can be afforded the outside is also pointed, and when this is done the house is fairly warm and comfortable—warmer than a solidly mortar-built house because the air enclosed in the dry walls is a non-conductor. The house has two doors, as some people think (and, indeed, as the people who live in the house will tell you), so as to use either side for entrance when it happens to be the lee side. There is something in this, because if you observe the window you will see that an open door is needed to give light; but the two opposing doors have another function—the peasant's small growing of oats is winnowed on the floor in the current of wind between the two doors. We, pampered people, know that a door opening directly from the outside is a draughty arrangement, and we protect ourselves with a porch and second door. It is still more draughty to have these two badly-fitting doors opposite to one another, and to mitigate the draught the closed-up door is lined inside with a plaited-straw mat (*sugan*, a paillasse), which is held up close to the door and the side chinks with raking props. The enclosure for the pig must be very strongly paved and secured, because these animals can perform wonders of destruction with their snouts. The fastenings for the cattle are hooked branches of bushes built into the wall. The bed mattresses are *sugans*. Other sitting accommodation is provided by stools (not shown). The principal table is the lid of the chest; the dinner is potatoes, and the dinner table is a flat basket placed on a bucket or stool. The roof is peculiar; the thatch is not of straw, and it is not secured with scollops. There is not much straw available, and scollops are not to be had; hazel bushes do not grow within twenty miles of this house. Note the network of roping and the row of stones along the eave. The foundation for thatch is prepared in the usual way, that is, a few collar-braced rafters (couples), pegged together with wooden pegs, are set up, then some rough branches are laid across them, and over these small branches are laid, lying up and down the slope of the roof. On these are laid "scraws," which are sods of a suitable kind skinned off the land very carefully and carried to the house in large rolls—one of these scraws may be two feet wide and ten feet long. The thatch is coarse sedgy grass, laid on carefully up and down the slope of the roof in sufficient quantity to give

the proper contour, without any fastening; it is held in its place by the network shown. In many of the cabins the work is badly done; ordinary straw-thatching is apparently imitated and the side of the roof is given a plane surface. Now it is easy to see that if there is not a rounded surface the network cannot give support or pressure to the grass thatch, and flat thatching is therefore bad and unscientific. The cords are mostly twisted, made from the same grass which is used for thatch; but cocoanut-fiber string is not uncommon—it stands the weather well and it is lasting. A rounded waggon-shaped roof is successful in this case, for much the same reason that it is successful as a felted roof. If you cover a flat piece of boarding with felt, any wind that gets inside (through a door or other opening) lifts the felt off the

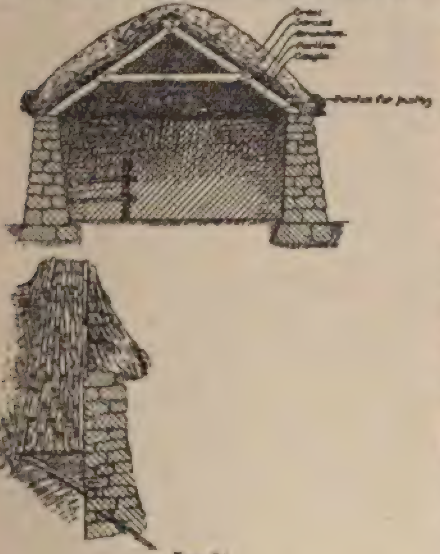


Fig. 78

boards, the nail heads pull through and the felt is carried off. With a waggon-roof it does not lift off; any attempt to lift at any part tightens it against the boards at every other part, and the friction against the boards helps the nails to keep the felt in place. The drawing shows the strings held down by stones along the eaves; they are quite as frequently fastened to pegs driven into the walls below the eaves. The drawing also shows the thatch covering the ends (the roof hipped) of the house, the gables. This is not the most common way, but it is the best way. With ordinary thatch a gabled house has the barges made to the thatch with mortar, and some care is taken with mortar flashings to the chimney stacks. This cannot well be done with loose grass thatch, and, as commonly done, the barges are a very unsatisfactory job; the method shown is quite good. This is the necessary kind of roof where the walls of the house are of dried mud (whether thatched with straw or grass), and with mud walls the eaves must be more projecting than as shown. If we take full account of all his surroundings, the builder of one of these humble dwellings may be a brother member of our craft who is fit to hold up his head among us.

55. Let us watch a man thatching with wheaten straw. He is putting on a "new coat" of thatch; he has moved his ladder, which lies evenly on the old thatch, and now marks the extent of the strip he is about to lay. The edge of the work he has before completed is kept from spreading by a number of straight scollops (hazel rods) stuck at right angles to the roof close to the edge of the new straw; he takes a handful of wheaten straw, regulates the butt ends with the palm of his right hand while he lays it in its place, then another and another, till he has as much as a scollop will properly span; he bends his scollop into a flat staple and thrusts it into the old thatch, enclosing the new. A second scollop brings him to the side of the ladder, then he takes a third and a fourth scollop, bends them sharp in the middle and pushes them in so as to hold fast the centers of the first pair; he lightly settles the scollops with his mallet, and repeats the operation till he reaches the ridge, where, if he is an artist, he finishes in lopped and twisted handfuls of straw which

are made fast by scollops in the loops in a way to remind one of the dowelling of roll ridge-tilling. The operation is exceedingly simple. Why does not the small farmer or peasant do his own thatching? Why also does he not make his own baskets and heather brooms or besoms? How many of us know the difference between a granny's knot and a reefing knot? Can anybody but a shopman make up a neat paper parcel? If we are to control workmen we must have their respect; if we are to have their respect we must understand their work. We must not only know bad work; we must know why it is bad work. We can only come to this knowledge by effort, and by becoming familiar with workmen, watching them intelligently at work and occasionally taking a hand ourselves.

56. Fig. 77 shows a Syrian house built of stone, such as may be seen in the neighborhood of Beyrouth. Because timber is expensive the walls are thick, and the roof is formed by vaulting. The face work is ashlar in alternating bands of light-colored and dark-colored stone. The roof is flat, and has a parapet. There is an outside stone stairs, and there are two shelters formed of cane mats on the roof (except in the rainy season the roof is the sleeping place). The opening through between the rooms is really the living room, and is designed for draught and coolness; the cane mats shown enclose the place and give privacy to the family. The windows are barred openings which may be closed up by the shutters shown. The way in which the centering for the vaulting is formed is as follows: Some pieces of timber are put up on sufcient supports, either timber or temporary dry walling—hewn pine pieces, kept to be let on hire for this purpose and charged for if cut or damaged in any way—the spaces between the planks are spanned with spauls of stone, and this is covered with mud which is worked to the shape of the vault. When the mud has dried so as to be fairly stiff it is covered with sand which is pressed firmly, and on this the sheeting is worked. It was a common plan in our own country to use wicker hurdles as lagging for vaulting. This house has a low parapet, four gargoyles are shown, and it has the usual flat roof of a Syrian house. There is no chimney. Cooking is done over small charcoal fires kept bright by the use of a feather fan, and only alight when they are required for cooking. Why are these roofs flat? What is the use of the small stone roller to be seen on every housetop (shown in Fig. 78)? The reason for the roofs being flat is very simple and natural: the roof is of clay or of a mixture of clay and lime, and it must be flat to prevent strong currents of rainwater washing it into channels and destroying it. The roller is for rolling the roof to close up cracks and generally consolidate and make the roof good during the "welcoming month" before the rainy season sets in.

57. Fig. 78 shows a house of the same character and giving the same accommodation as Fig. 77, but it is built of unburnt sundried mud blocks instead of stone. Houses of this kind are to be seen at Zahleh in Lebanon, where the eastern slope of Gebel Sunnin approaches the plain of the Bukaa. A brawling stream from the mountains runs through the little town, and on its banks some poplars grow; these poplars appear to furnish the poles to carry the clay roof. There are many other places where the houses are of mud (Damascus is a mud-built city). The poles are cleared of their bark, and when one gets inside the building he finds that peeled small branches have been laid to form simple patterns lying on the poles, showing appropriate ceilings having a good decorative effect. The doors of these houses have wood hinges; they are fastened with wooden locks which are opened with wooden keys. The projecting eaves protect the mud walls from being

washed by the heavy rains of the rainy season.

Fig. 79 shows one of these locks wtih its key. The "Encyclopædia Britannica" says: "The earliest lock of which the construction is known is the Egyptian, which was used four thousand years ago." This is the common lock used on the doors of these Syrian houses.

58. Have such elementary buildings any architectural value? The Eastern houses between which and the Connemara cabin some comparison is suggested are not nearly the poorest kind of dwelling to be seen in Syria. There is evident intentional efforts at decoration, and they also have a satisfactory

Fig. 76

Fig. 77

effect when seen from a distance. A village of these houses built on rising ground, placed as the houses of Eastern villages are, without any regard to regularity in respect of road or street and mixed with the green of a few mulberry bushes or similar things, is a very pleasant sight. The builder of such houses has very little room for the display of originality; he works to a cut-and-dry design, a type as permanent as the dress which poverty makes unchanging in countries where people can barely live. Yet in such houses there is room for the display of taste and skill.

I must not be understood as saying that habitations like the Connemara cabin are satisfactory for human beings to live in. We have a Public Health Act, and we have sanitary offcers and inspectors, and we have laws by which the district council may build suitable houses for laborers; but these remedies do not touch, in any practical way, the evil. Where the ratepayers of a district are all equally poor, they cannot collectively help each of them to a new house with reasonable accommodation for animals and separation of the sexes. Our political conscience has reached a point at which it is allowed that civilization may say, without suspicion of socialism, "We will not allow the owner of a soul to die of hunger."

(To be Continued.)

Concrete Pipe Foundations.

THE exigencies of foundation work in soft ground are often met by concrete piers, sheet piling and other means; but lately the use of concrete piles has replaced much of the older methods. The concrete pile foundation is largely used in New York, where tall buildings on the soft substratum have to be carried, and where deep excavations and often pneumatic caissons have to be employed. The concrete piles may be driven without excavating and the cost of piers avoided. As no excavation is necessary there is no danger in undermining adjoining buildings or of pumping, and the work can be done much more expeditiously. Concrete piles are also permanent, whereas wooden ones have to be kept saturated. The concrete steel pile is quite free from these drawbacks, and can be used in the wettest as well as in dry soils. The Engineering Record lately gave some particulars of the concrete pile foundation for the Hallenbeck building addition at Park and Pearl streets, New York, a ten-story steel frame structure. The wall columns of the older part, carried on I-beam grillages imbedded in the concrete caps of clusters of wooden piles, was found, owing to the lowering of the ground-water level, due to the drainage caused by the rapid transit subway near, to be too costly. The wooden piles would involve trenching

several feet below the bottom of footings, and underpinning would be necessary to carry the foundations down. The concrete pile plan was found to be less costly, so was adopted. The contract specified a substructure composed entirely of reinforced concrete piles, extending to a height of about six feet above the ground-water level, where they are then made integral with the concrete grillages and concrete floor slabs. Sections are given in the Record of the concrete-steel piles and girder seats. The foundations consist of clusters of piles in two longitudinal rows, which carry transverse cantilever I-beam girders. These support the wall columns beyond the centers of the piles. The Record describes the piles. The piles are twenty-eight feet long, twelve inches square, made with 1:2:4 Portland cement concrete, with one-half inch crushed trap rock rammed longitudinally in wooden moulds. The piles are calculated to support 80,000 pounds each, including a load of 36,000 pounds per square foot on the concrete, as allowed by the New York building laws for concrete piers, and are capable of receiving an additional load of 44,000 pounds, which is assumed will be supported by the four soft steel vertical reinforcement rods, which are bedded in the concrete, and are allowed to work in compression up to a load of 7,000 pounds per square inch. These rods are tied together on all sides by horizontal hooked wires five inches apart, and at the bottom they are bent to the angle of pryamidal pile point, and are seated on a solid cast-iron driving point locked to the pile by wrought strips bent 90 degrees at the top. The whole of the reinforcing rods of the hooked wires are embedded in the concrete, which forms on plan a square 12 inches. The four reinforcement rods are placed at the four corners of the pile surrounded by concrete. Each rod is one and seven-sixteenths inches in diameter. The section shows how the rods converge at the bottom and rest on the solid cast-iron driving point above mentioned. The cast-iron point is pierced by a one-inch jet hole through its center, and the jet pipe is brought outside the pile. The bottom pyramidal part of pile is also strengthened by wrought-iron strap. The concrete extends two inches above the tops of rods, so as to form a seat for the driving cap. Mr. H. C. Pittman is the architect and Mr. F. A. Burdette, C. E., the consulting engineer for the steel construction, designed the substructure. The vertical rods are intended to be made to connect directly with the grillage, which is also reinforced.

It has been estimated by an expert in the employ of the government that agricultural machinery reduces the number of men employed to do a given amount to one-third, while manufacturing machinery reduces the number to one-fiftieth.

Nearly 30,000 patents were issued at Washington last year. We are an ingenious people and invent a great many things that cannot be used.

The English statute mile was first defined in the thirty-fifth year of Queen Elizabeth. Before that time it was put down at 5,000 feet.

The Chicago Alumni of the Engineering Department of the University of Michigan have ordered a portrait of the late dean of the department, Prof. Charles E. Green, from the well-known artist, Mr. Ives, of Detroit. The portrait is to be placed in the new engineering building as a memorial to Prof. Green.

Paris has no less than 1,216 classes of workmen. There are, for instance, 386 classes engaged in the chemical trade and 370 in metal industries.

The Botallic mine in Cornwall runs for two-thirds of a mile out under the sea.

HOME STUDY.

Elementary Mechanics.

The First of a Series of Articles on the above Subject.

BY N. C. HURST.

MECHANICS is the science of rest motion and force. It treats of the laws of equilibrium and motion and is subdivided into *Statics* or forces at rest and *Dynamics* or the effects of forces when motion is produced on bodies in motion. Thus *Statics* apply to structures such as roof trusses, bridges, etc., or any structure or body that is practically fixed or rigid while *Dynamics* applies to force in motion or transmission machinery such as gear trains, shafting while transmitting power and all machinery used to convert potential energy into motion or active work. *Elementary Mechanics* then, from the definition of the work elementary, treats of the fundamentals or first and simplest derived relations of rest, motion and force. Before taking up and discussing the various relations of these quantities and applying them to even the simplest of mechanisms we must first get a clear idea of their meanings as they are used in the mechanical world.

Rest and *Motion* of a point or body (a point being considered a body of very small dimensions or size) is always relative to some other point considered as a fixed point or point of reference—a fixed point in applied mechanics being a point at rest with respect to the earth or to the structure as a whole. Now suppose we take two points and join them with a straight line. If this line does not change in length nor position the points are said to be at rest with respect to each other and to each other only. If the line changes direction one point must be revolving about the other or if the line changes length the points are moving from or toward each other or the line may change both in length and direction. Upon a little reflection we see that there may be more than two points to consider and that these points may, while at rest with respect to each other, be in motion relative to some other point. As an illustration consider two or more mountain peaks on the earth's surface. With respect to each other they are at rest, but with respect to the sun are in motion since the earth revolves about its axis and it in turn about the sun. Thus we see that *Rest* and *Motion* are essentially relative.

Force is an action between two bodies causing or tending to cause changes in their relative positions or motion. Our only idea of force is ob-

tained through muscular sensation or observing the work of some machine, such as a hydraulic forging press or the moving of a heavy object.

With a clear idea of rest, motion and force we will now discuss some of their combinations or derived quantities and condition that must be fulfilled.

Work is the product of a force by the distance which is passed through in the direction of the force by the point of application. It is expressed as *foot pounds*, being the product of the force in pounds and the distance moved in feet.

Moment is the product of a force by the shortest distance of its line of action from a fixed point or fulcrum. It is expressed as *pound feet* or *pound inches* to distinguish its from *work* which is of the same dimensions. Some authorities express *moment* by the word *poundals*, thus avoiding possible confusion with *work*.

Power is the rate of work or the doing of a certain number of foot pounds of work in a given time. Thus when 33,000 foot pounds of work are done in one minute the power exerted is called one *horse power*.

Equilibrium is that state which exists when all forces acting upon a body, mechanism, or point balance each other and the body, mechanism, or point is at rest or moving at a uniform rate of speed. It exists when action is equal to reaction or when the impelling force is equal to the resisting force or when the work delivered by a machine is accounted for in output or work done. If this condition is not fulfilled it means that the body or mechanism is either gaining or losing velocity and will continue to do so until a state of balance or equilibrium is reached. Equilibrium in a business sense means a balance of accounts, i. e., that the difference between the debit and credit columns must be equal to zero. The mathematic expression used to represent this condition represented thus ($\lessgtr$ m=O). (M) we will say represents moments about the particular point in question and ($\lessgtr$) means "the algebraic sum of all such terms as" or the algebraic sum of all the moments, forces, work, or whatever we may be dealing with. This expression $\lessgtr$m=O) is the *vital equation* in all investigation in mechanics and a thorough understanding of it must be had before the moments, forces, etc., acting on a body can be intelligently dealt with. As a simple example let us investigate the action and reaction between a table and a five-pound block or iron placed upon it. Let the weight of the block be represented by (W) and let us assume that the table is strong enough to support the block or in other words the block and table are at rest, or in equilibrium. Let the reaction of the table be (W'). Now since action is equal to reaction (W'=W). Transferring (W) to the left side of the equation, remembering that the sign of (W) must be changed in doing this, we have (W'—W=O,) or the algebraic sum, which fulfills the condition ($\lessgtr$ W=O). Here the upward force is taken as (+) or force positive and the downward force as (—) or negative.

With a thorough understanding of the meanings of rest, motion, force and their derived quantities and the conditions that must be fulfilled, let us now apply them and analyze some of the simpler mechanical appliances beginning with the ordinary lever and drive the various equations or expressions expressing the relation of the various quantities involved.

Let Fig. 1 represent a lever of length (l), the length of the two arms being (*a*) and (*b*). Let (P) be a force acting at the end of (a) and (p) be a force acting at the end of (b). (*o*) is the fulcrum point or fixed point. The moment on the left hand end of the lever is P$\times$a, P being the force and (a) the shortest distance from the line of action of (P) to the center (*o*) or fulcrum. The right hand moment is ($p\times b$) where (p) is the force and (b) the shortest distance from the line of action of (p) to the

fulcrum (O). The moment ($p\times b$) turns or tends to turn in a right hand or clock-wise direction and is generally called (+) or positive, while the moment ($P\times a$) turns or tends to turn in the opposite direction and is called a (—) or negative moment. In order to fulfill the requirements of equilibrium we have $p\times b=P\times a$ (1)

or $P=\dfrac{p\times b}{a}$ (2) or $p=\dfrac{P\times a}{b}$.

Throwing equation (1) into the form $\Sigma\ m=o$ we have $p\times b-P\times a=O$ which is the algebraic sum of all the moments. Equation (1) admits of finding either of the quantities a, b, P or p when the other three are given and apply when the lever is stationary or revolving about (O) at a constant rate. Let us now assume that the lever is stationary and horizontal and that the forces (P) and (p) are known and act vertically, and that the value of the force (F) at (o) is desired. Since the lever is in equilibrium the algebraic sum of the vertical forces must equal zero, we have ($F=P+p$) or $F-P-p=o$ which fulfill the expression (Σ P=o). The value of (F) may be found by the use of moments if we will assume that the fulcrum or reference point is transferred to the end of the lever, say at (O'). Then we will have ($p\times l=F\times a$) or

$F=\dfrac{p\times l}{a}$.

In Fig. 1 the forces (P) and (p) were assumed to act vertically or at right angles to the center line of the lever. This is really a special case and so let us now consider a general case where the forces take any direction at some one position of the lever. Fig. 2 represents such a case. Here the right hand or (+) moment is represented by ($p\times o$), (od) being the shortest distance from the line of action of (p) and the center or fulcrum (o), the angle $od\ F$ being 90°. The left hand or (—) moment is represented by ($P\times oc$), (oc) being the shortest distance from the line of action of (P) and the center (O). The finding of the valve and direction of the force (F) acting at the center (o) will not be considered at present as it involves what is known as the parallegram of forces which will be considered after the fundamental mechanical movements have been discussed.

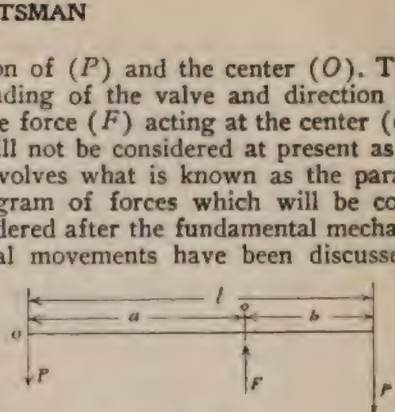


Fig. 1

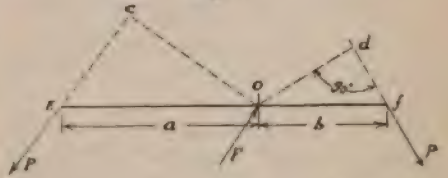


Fig. 2

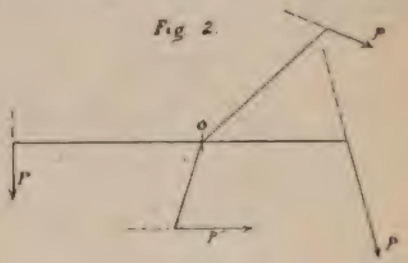


Fig. 3.

Fig. 3 illustrates a lever with four arms and acted upon by four forces, one at each of its various arm ends, thus dealing with four moments about the center or fulcrum (o). The expressions representing the relation of the moments in this case are derived as in the cases of Figs. 1 and 2, i. e., by following the expression Σ m=o.

The analysis of Fig. 1 also applies to a train of gearing, since a train of gears is really nothing but a system of revolving levers, either simple or compound, and the fulcrum points are the gear centers and the arms (a) and (b) assumed to be the radii of the pitch circles. The forces (P) and (p) being taken as acting perpendicular to the radii or tangent to the pitch circles. So if we know the force applied to one gear we can determine

the force on the teeth of all others in the train, thus obtaining data for calculating the size of the teeth, arms, etc. The analysis of any system of levers, gears, etc., is the easiest kind of a problem if we work step by step, with the definitions of the various terms in mind and follow the meaning of (≨m=*o*).

We will next take up the other mechanical motions or leverages that are often looked upon as being more complicated than the ordinary lever. We shall see that all mechanical motions are special cases of the lever, no matter what mechanism we consider, they all sift down to (≨m=*o*).

Elementary Course in Mechanical Drawing.

(Continued from December Issue.

SINCE Plate IX was not given in the December number of The Draftsman the problems are repeated.

PLATE IX.—Problem 1.

In Fig. 1, *ab* is the side view or elevation of a 3 inch circle. Draw the plan or top view.

ab is $5\frac{1}{2}$ inches below the top border line of the sheet, the center *O* is 2 inches from the side and $2\frac{1}{2}$ inches from the top border lines.

Problem 2.

Fig. 2 is an elevation of a *frustum* of a 2 inch circular cone, 3 inches high, which is cut off 2 inches above the base by a plane parallel to its base.

Find the plan view and the location of an element (that is, a line on the surface of the cone drawn from the apex to the base).

The element makes an angle of 45° with the axis in the plan. Then a plan or top view would be projected above the elevation, when using the third angle method, and the plan will appear as if the cone had been crushed flat.

Any *element* as *xy* may be shown in the elevation by projecting down from the plan with lines perpendicular to *mn*, cutting *po* and *mn* in x' and y', in the upper and lower faces of the frustum

The elements of a cone between the bases of a frustum are equal and any one is called ***the slant height of the frustum.***

Problem 3.

In Fig. 3, is shown only the plan of a hexagon prism, which is $2\frac{1}{2}$" across points and 3" high in the elevation which the student is to produce.

O is $1\frac{3}{4}$" from the top border line and $8\frac{3}{4}$" from the one on the left. The base of the elevation of the prism to be on a line with bottom of Fig. 2.

Problem 4.

In Fig. 4, a circular cone $2\frac{1}{2}$" in diameter and 3" high is cut by a plane 1" below the apex, the cutting plane making an angle of 30° with the base. *O* is $1\frac{3}{4}$" from the top and $4\frac{3}{4}$" from the right border line of the sheet. Base of Fig. 4 is on same line as the bases of Figs. 2 and 3.

Draw a given number of elements in the plan view and project to the base of the elevation and connect to the apex, as shown.

These elements cross the plane *mn* in several points as 1, 2, 3, 4, 5 which when projected to the plan cut the elements in points 1', 2', 3', 4' and 5' and in 1", 2", 3", 4" and 5", which are points in the curve representing the top view of the shape produced by cutting a cone with a plane *mn*.

Project the elements *co*, *fo*, etc., to the side view and connect to the apex as shown.

To find the points in the elements in the side view, take o"7'=o'7 and project to 7". o"8'=o'8 and project to 8". o"9'=o'9 and o"10'=o'10 and so on until all elements in the side view are crossed by points.

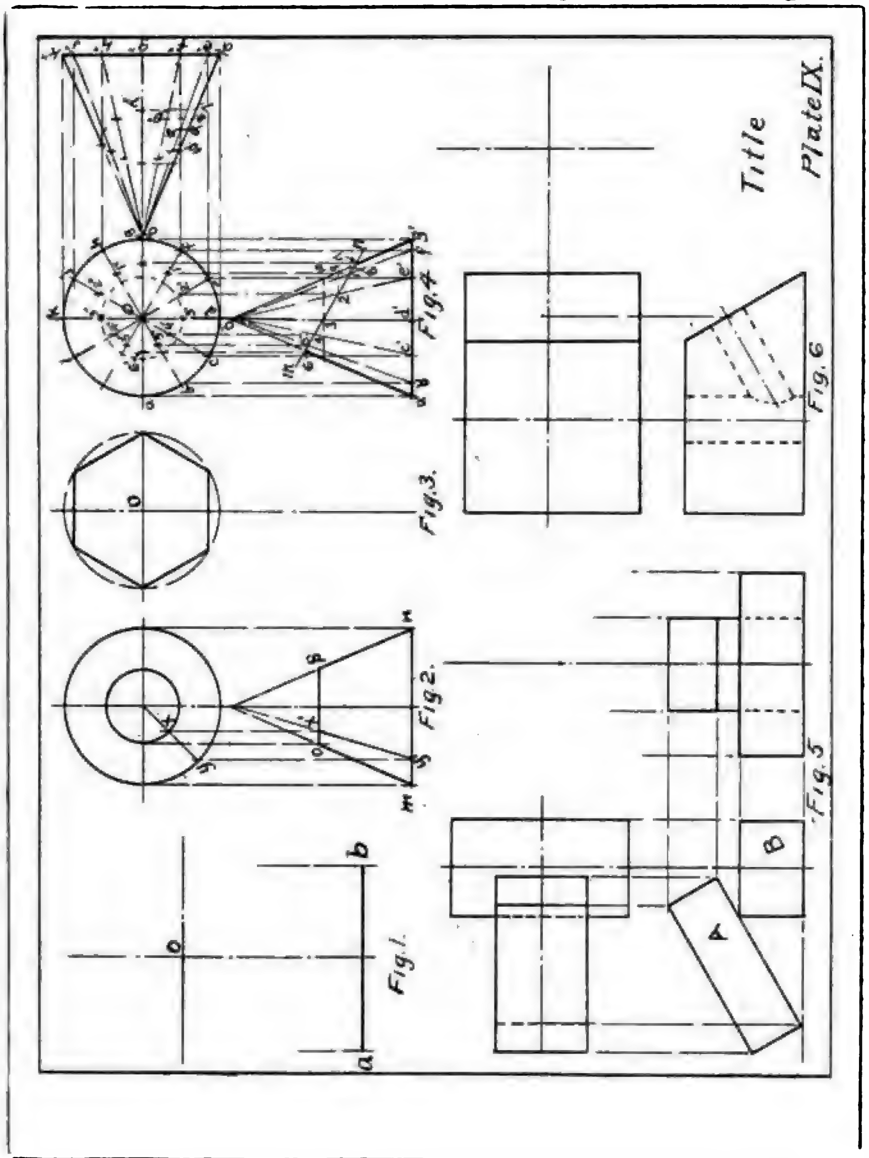
Point 3' and 3" is found in the top view by taking a circle of radius 3-10.

Problem 5.

Two blocks are so placed that one lies on the other at an angle of 30°. Block *A* is $1\frac{1}{2}$" wide, 1" thick and 3"

long. Block *B* is the same size, is laid with its center $3\frac{1}{2}$" from left border line and the center of the side view is 7" from the same border. The center of the top view is $4\frac{3}{4}$" from bottom border line while the base of block *B* is $\frac{1}{2}$" from that line.

Draw views as shown, then produce a top view of the right view of *A & B*, getting such lengths as are necessary from the present top and side views.



Problem 6.

Draw a truncated prism, lying on its long side, which is 4".

The right side is at an angle of 60° and the block is 2" high by 3" wide. Through the center of the top face is a $\frac{3}{4}$" hole and one of the same size perpendicular to the slant face at a point $\frac{3}{4}$" from the top.

Finish the top view, also an end view of this top view on the center lines shown and show the holes as they will appear in these views.

PLATE X.—Problem 1.

found by projecting from "*A*."

The size of the block will be 4" long, 2¾" wide and 2½" deep.

The size of the slots will be ⅜"x 1¾" long, placed centrally of the

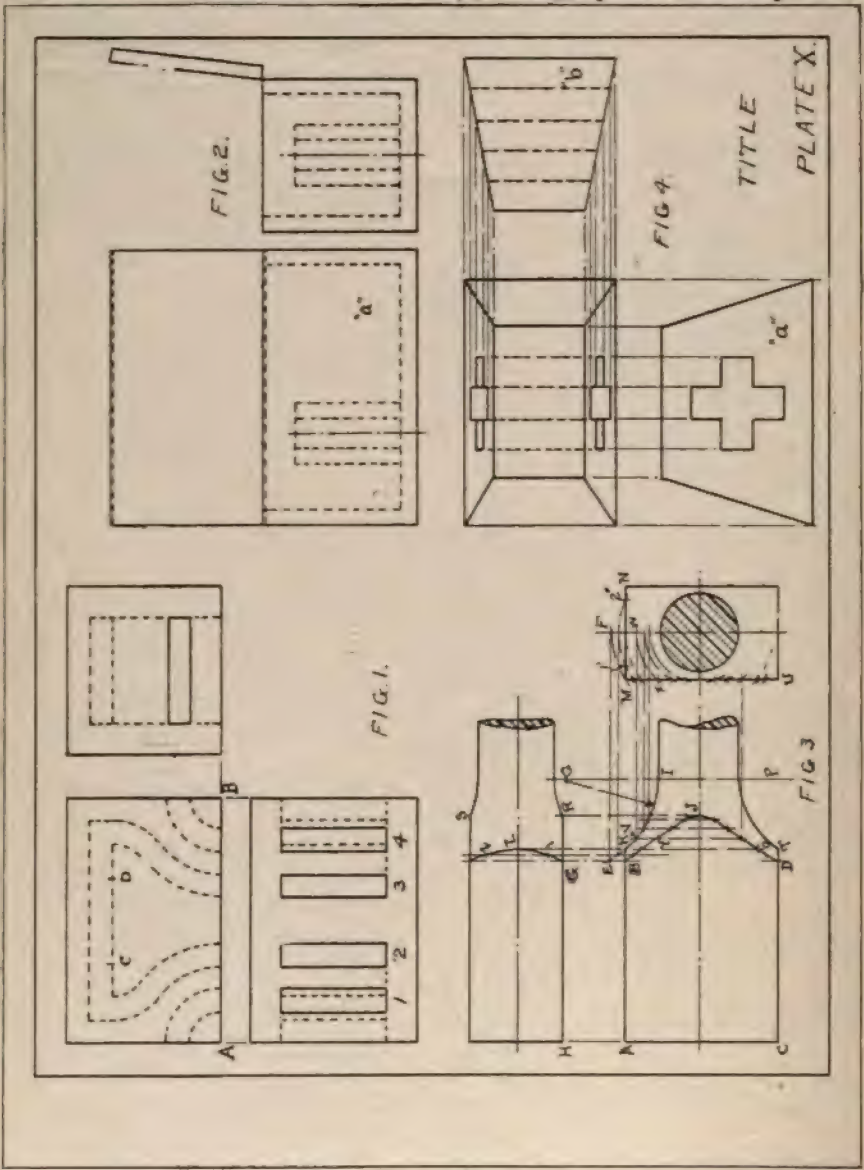


Fig. 1 represents a rectangular block with a number of curved slots cut through it. The view shown at "*A*" should be laid out first and the curved slots located. *b* and *c* may then be lower view.

Slots No. 1 to 4 are ½" from the ends. The curves are drawn with a radius whose center is located at *A, B, C, D* and the smallest being ½".

Problem 2.

Fig. 2 shows three views of a rectangular box with a cylinder placed in one end and the lid of the box raised to make an angle of 15° with the vertical side of the box. Lay out the view at "*A*" and the other views may be found from it.

Box to be 4½" long, 2½" wide and 2½" high and ¼" thick. Bottom line of box 6" from top border line and view "*A*" set with 3½" from right border line, cylinder is 1" diameter, 1¾" long and has ½" hole in it, and is set centrally in the end view, but off the center ¾" in the front view.

Problem 3.

Fig. 3 shows three views of the end of a common form of engine connecting rod. The rod is 1¼" in diameter and ends in a rectangular piece whose sides are parallel.

AC is 2½", *MN* is 1½" and *HG* is 3". Draw front end and top views as shown, making *HAC* ½" from left border line and *CD* ¾" from the bottom one. Center line of top view should be 1¾" from *AB* and center line *F* should be 6¾" from *AC*.

Draw projection line *BG* and extend to *D*, then rotate corner *M* to *F* and project *F* to *E* on line *BG*.

With a radius of 1½", draw an arc through *E* and tangent to the rod at *I*. Produce line *QIP* and strikes arcs in top view and side views and extend *CD* to *T*, *AB* to *K*, *HG* to *R* and likewise the line to *S*.

Draw in a few lines crossing the front and top view and cutting the curve *EKI*, project these points to line *F*. Revolve them to line *MU* and project back to their respective lines, thus *V* to *W* around to *X* and then back to *Y*.

Project *R* down to *J* and *K* to *L*.

By the above arrangement, points in the curve *BYJOK* may be found. Points 1-2 in the top view are found from 1'-2' in the end view.

Draw in the curves with a French curve.

Problem 4.

Fig. 4 represents three views of a truncated pyramid with a hole in the form of a cross cut through it in one direction.

The view shown at "*A*" should be laid out first and the others may be found by projections from it as indicated.

The object has a bottom face of 4"x2½" and the object is 2½" high. Also a top face 1"x 2½".

In view "*A*" the cross is up ½" from bottom and is 1½" long, each division being ½" each way, hence in view "*B*" the dotted lines are ½" apart.

CHAPTER V.—Sections.

If we should pass a plane through an object in any direction, and remove the part of the object which was in front of the cutting plane, and then project what was left of the object behind the cutting plane, upon a second plane, parallel to the first, the view thus shown would be a *section*.

Sections are taken to show the internal shape of objects and are often necessary in practical working drawings to clearly represent what is not shown by the other views.

The principle of *sections* may be studied by the use of simple geometric solids.

Reference has already been made to sections in Chapter I, under the head of "Section Lining," but nothing is given except the proper lining for the different materials used in mechanical work.

In practical working drawings, the objects are often shown entire in one view and in section in another, and the position of the section should be indicated by a dot and dash line in the view in which the plane of the section is seen edgewise, but if the view represents the object when the part in front of the cutting plane is removed, the line of the section should be represented by a full line upon the object.

It is customary to show the surface cut by the plane by "cross hatching" it with parallel equidistance lines as shown in Chapter 1.

Often the draftsman will make the shape of a section right on the object itself, as if it (the section) was revolved on its axis into the plane of the

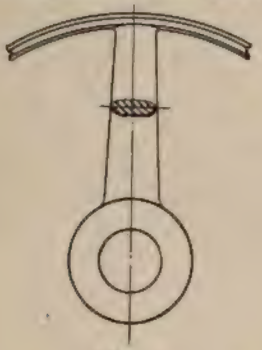


Fig. 1.

paper as in the case of a pulley arm, Fig. 1, or a yoke for a valve, the latter being shown on Plate XIII. The ob-

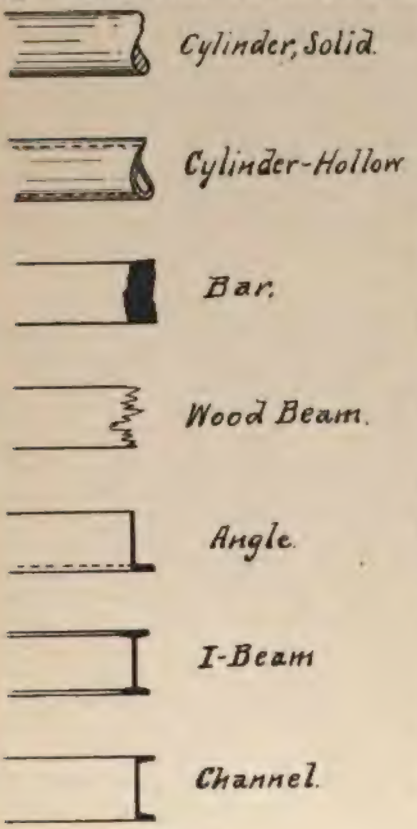


Fig. 2.

ject should be drawn to the size of the dimensions, which may be placed on the drawing if desired.

The shapes used in mechanical work are often broken and a section shown

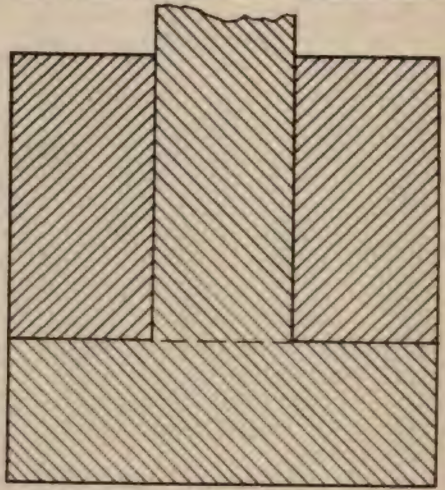


Fig. 3.

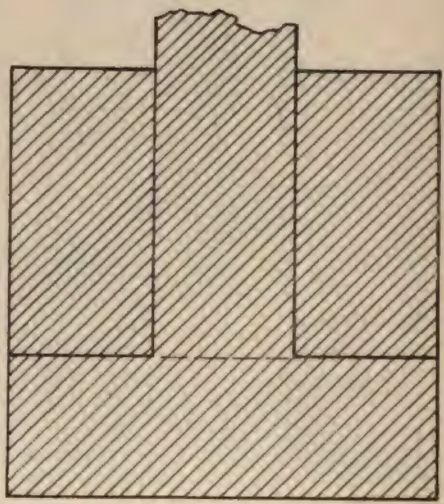


Fig. 4.

as in Fig. 2, so to more clearly represent their true character.

When a section of an object appears in more than one view, the "cross hatching" should be in the same direction for that part and when one or more parts are sectioned the "hatch-

ing" should be as in Fig. 3 and not as in Fig. 4.

When the plane of the section passes through the axis of a bolt on shaft, it is customary to let the bolt or shaft remain whole and it will then appear as a front view of the object, as in Fig. 5.

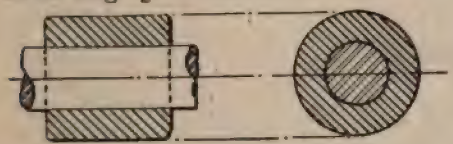


Fig. 5. *Fig. 6.*

If the section is at right angles to the axis, as Fig. 6, the bolt or shaft is sectioned according to the material of which it is made.

The simplest sections are those of the sphere every section made by a plane, whose diameter may vary from the diameter of the sphere to that of a circle as small as can be imagined.

PLATE XI.—Problem 1.

To show a section of a 2" sphere made by a horizontal plane ⅝" above the center.

The plane cuts the elevation *C* in 1-2 and in projecting to the top view, points 3-4 are found on the center line. A circle of diameter 3-4 will be the view of the section.

Center of circle "*C*" placed 2½" from left border line of the plate and 4½" from the top.

Place the section directly above, using center lines and "hatching" as shown.

Problem 2.

The section of a cylinder varies with the position of the plane, it is a circle, a rectangle or an ellipse, according as the cutting plane is perpendicular, parallel or oblique to the axis.

In Figs. 2 and 3, the cylinders are 3½" long and 2" in diameter, the cutting plane being 2" from the bottom in Fig. 2 and ¾" from center in Fig. 3.

In Fig. 4, the section is an ellipse which appears as a straight line in the front view and as a circle in the top view, its real length being seen in the front view. Then the true view of the section will be projected perpendicular to its face, at *FC*. The width 1'-2' is found from 1-2 in the top view and any line as 3'-4' will be taken 3-4 in the top view.

To obtain other points, locate any point, as 5, and project it to the top view, finding 6-7, then lay it off on 6'-7' on the section, projected from 5 perpendicular to *AB*. Proceed the same with other points and draw in the outline of the section with a French curve.

Make the cylinder 2" and let *DA* be 1" with *AB* drawn at 45. The center of the section *FG* should be about 3" from *AB* and parallel to it. Center of cylinder 2½" from right border line. *AB* may be divided into eight parts if desired.

Problem 3.

Pass a plane through a cone parallel to one side and show the true shape of the section, also a top view, Fig. 5. Cone to be 2" diameter and 3" high, plane to be passed ¾" from the side.

The front and top views are on a central line 2½" from the left border, the front view being 1" up from the bottom border line of the sheet.

Locate cutting plane and project to top view as shown, in 1'-2'. The center line of the section is to be 2½" from the cutting plane, the 1"-2" being 1'-2' in the top view. Draw several section lines as 3-4, 5-6, etc., project 4, 6 and 8 to line *AB* and draw in the curves, drawing lines through top view, cutting the circles, from the intersection of the cutting plane and lines 3-4, 5-6, etc., in the front view. The lines of the section view, perpendicular to *CD*, are 5"-6"=5'-6', etc. from the top view. Find the points in the top and section view and draw the shapes with the French curve.

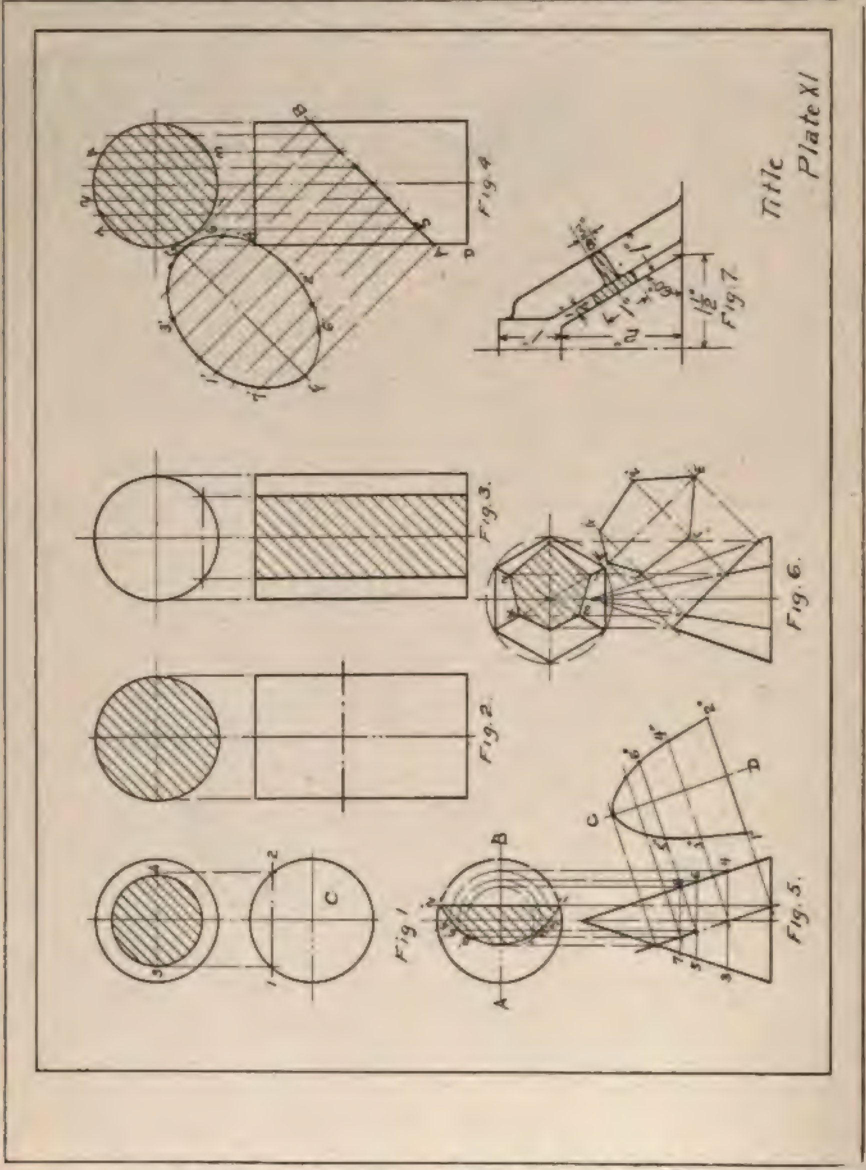
Problem 4.

Pass a plane, at an angle of 60° with the horizontal through a hexagonal pyramid and show a top view of the

section, also its true shape, Fig. 6.

Long diameter of hexagon 2", pyramid 3" high, center of section view *EF*, 2" from cutting plane, which cuts the pyramid 1¼" up from the base on as 1-2 and 3-4 in the top view. Draw in the outline of the shape of the section.

The top and side views may interfere some if the space does not permit,



the center line. Project to top view and connect the points on the diagonal lines, 1, 2, 3, 4, etc.

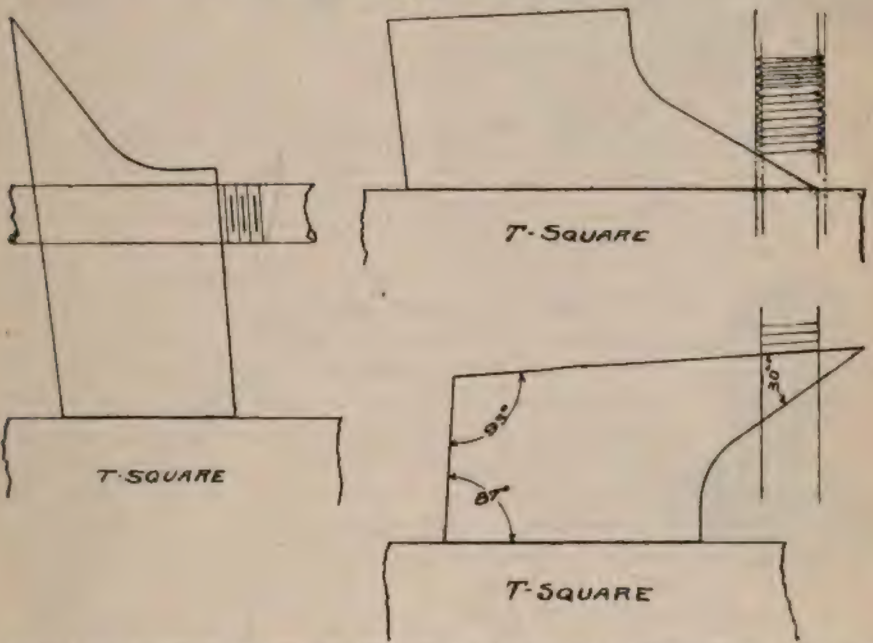
Lines 1'-2' and 3'-4' are the same Fig. 6 to go in without cutting into Fig. 3.

The base of Fig. 6 is 1" above the border line and center line is 8" from left border line.

Problem 5.

Show the valve yoke, Fig. 7, and the section as shown, using the dimensions and locating the center 5" from right border and 2½" up from the bottom line, thus leaving room for the title of the plate.

A Handy Triangle.



Some time ago a reader of "The Draftsman" sent in the following sketch of a handy little triangle, though not a triangle it is handled in the same way,

The sketches will no doupt explain its use in one respect though several other angles might be arranged for if the material is large enough. It was made from a piece of an old triangle and was cut and trued up to the proper angle,

The name of the designer of this instrument is desired so he may get the full credit for this article and sketch.

New Expansible Steel.

One of the most remarkable and valuable properties of nickel-steel is revealed by the discovery of the French scientist, Guillaume, that when the proportion of nickel in the alloy is a little above 36 per cent., the coefficient of expansion, with rise of temperature, sinks to the lowest point known for any substance. Indeed, M. Guillaume avers that a nickel-steel can be made with no coefficient of expansion at all. Experiments in this country have resulted in the production of nickel-steel with so slight a degree of expansibility that in practical work it can be entirely neglected. The usefulness of such a material for making instruments of precision is evident. But at present the cost of making the alloy is too high for its employment in building and the manufacture of heavy machinery.—Science.

CURRENT TOPICS.

Mr. "Joe Cone" a Draftsman and Poet.

Joseph A. Cone, or "Joe Cone," as he is best known, the subject of this sketch, was born in Moodus, Conn. November 13, 1869. Moodus is a lively country town in which are located 14 cotton twine mills of national repute.

Here is where Mr. Cone made his start in the mechanical life. Until 18 years of age he by turn went to the little village school, worked on his father's farm and in the mills. His first real trade was that of printer, then at the age of 20 he entered the construction department of the American Net and Twine Co., (a branch of which was then located in East Haddam, Conn., near Moodus,) as apprentice. With this firm he has remained ever since, going to Boston when the plant was removed in 1890.

Immediately on his removing to Boston he entered the Cambridge, Y. M. C. A. night schools, winning three diplomas in three years, after which he became a member of the American School of Correspondence. Being persistent in his studies, and aiming only for the highest he has risen to the position of chief draftsman and designer of the American Net and Twine Co., a corporation employing between 600 and 1,000 persons. In addition to this he is head instructor in Mechanical Drawing and Machine Design at the Cambridge Institute.

Born with a love for literature Mr. Cone has gratified his tastes in that direction to the extent of contributing to the leading journals and magazines of the country, many of his contributions appearing in the columns of The Draftsman. He has also published a volume of successful verse, "Heart and Home Ballads," is literary editor of "The Suburban," a well-known Boston weekly, and is a member of The Harvard Union.

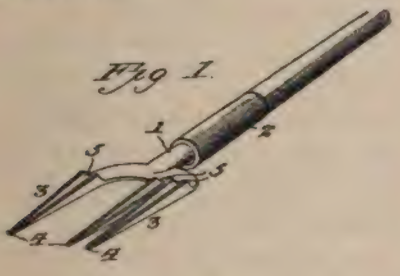
As an inventor, designer and draftsman, Mr. Cone is well known in the netting manufacturing business. He resides in Cambridge, Mass.

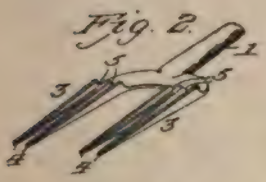
The Illustration in this article is gretited to the " Four Track News."

A New Ruling Pem.

THIS invention relates to improvements in ruling-pens; and the object is to provide an improved multiple ruling-pen by means of which a number of parallel lines may be simultaneously drawn with the same ease and facility with which a single line may be drawn with the ordinary construction of ruling-pen.

With the above object in view the invention consists in the novel features of construction.





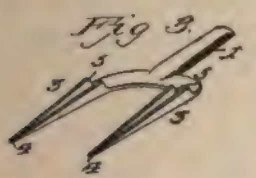


Figure 1 is a perspective view of one form of my improved pen in connection with a suitable holder, and Figs. 2 and 3 similar views of different forms of the pen.

Referring now more particularly to the drawings, 1 designates the shank of the pen, shaped at one end to fit in an ordinary pen-holder 2 and carrying at its opposite end a fork-shaped portion the forks 3 of which are formed each with one or more ruling-points 4. As illustrated by the drawings, the shank, forks, and points, together with the usual ink-reservoir 5 for each point, are formed from a single piece of metal.

In Fig. 3 is shown the pen provided with one ruling-point for each of the fork members, with which construction two parallel lines may be drawn with a single stroke of the pen. In Fig. 2 the pen is provided with two points for each fork, so that four parallel lines may be simultaneously drawn---that is, two sets of two lines each, the lines of each set being comparatively close together and the two sets being separated at a greater distance from each other.

Fig. 1 illustrates a pen having one of its forks provided with one ruling-point and the other fork with two points. With this pen three parallel lines may be drawn at each stroke, two of them being arranged comparatively close together and the third one at a greater distance.

The number of ruling-points carried by each fork and the relative arrangement thereof may be varied to adapt the pen for different kinds of work without departing from the scope of the invention.

From the above description it will be seen that here is produced a very simple construction of ruling-pen which will be especially useful to accountants, bookkeepers, draftsmen, and others.

Farm laborers in Mexico may be employed at from eighteen to twenty cents a day, though in many parts of the country they are scarce and unreliable.

MATHEMATICAL.

"Can you put two and two together?"

"Not so well as one and one; I'm a minister."—Detroit Free Press.

Discovery of Dynamite.

Terrible Explosive First Prepared by an Italian Chemist in the Year 1845.

Few people know what dynamite is, though the word is in common use, says the American Syren and Shipping Journal. It is a giant gunpowder; that is, an explosive material, varying in strength and safety of handling according to the percentage of nitroglycerin it contains. Nitroglycerin, whence it derives its strength, is composed of ordinary glycerin and nitric acid, compounded together in certain proportions and at a certain temperature. Nitroglycerin, though not the strongest explosive known, being exceeded in power by nitrogen and other products of chemistry, is thus far the most terrible explosive manufactured to any extent. Nitroglycerin by itself is not safe to handle, hence dynamite is preferred.

It is extensively made and consumed in the United States under the various names of Giant, Hercules, Jupiter and Atlas powders, all of which contain anywhere from 30 to 80 per cent. of nitroglycerin, the residue of the compound being made up of rotten stone, nonexplosive earth, sawdust, charcoal, plaster of paris, black powder, or some other substance that takes up the glycerin and makes a porous spongy mass.

Nitroglycerin was discovered by Salvero, an Italian chemist, in 1845. Dynamite is prepared by simply kneading with the naked hands 25 per cent. of infusorial earth and 75 per cent. of nitroglycerin until the mixture assumes a putty condition not unlike moist brown sugar. Before mixing the infusorial earth is calcined in a furnace in order to burn out all organic matter and it is also sifted to free it of large grain. While till moist it is squeezed into cartridges, which are prepared of parchment paper, and the firing is done by fulminate of silver in copper capsules provided with patent exploders.

Nitroglycerin is made of nitric acid one part and sulphuric acid two parts, to which is added ordinary glycerin, and the mixture is well washed with pure water. The infusion is composed of small microscopic silicious shells which have lost their living creatures. The cellular parts receive the nitroglycerin and hold it by capillary attraction, both inside and out. The earth is very light. Water is expelled from it by means of a furnace and then in the form of a powder it is mixed with nitroglycerin. Nitroglycerin has a sweet, aromatic, pungent taste, and the peculiar property of causing a violent headache when placed in a small quantity on the tongue or wrist. It freezes at 40 degrees Fahrenheit, becoming a white, half-crystallized mass, which must be melted by the application of water at a temperature of 100 degrees Fahrenheit.

In Reference to "The Drafsman"

Many good articles are being prepared or the pages of THE DRAFTSMAN of which the following are a few:

Plane Trigonometry, its theory, application and use by Reed R. Lewis, C. E. This will be the forepart of a number of articles showing its application to engineering work and any draftsman or student can follow them.

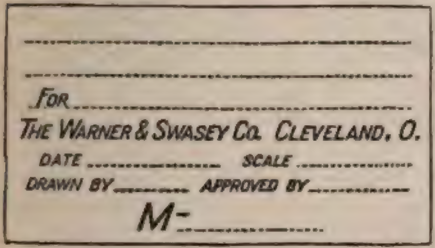
Several articles to come on Elementary Mechânics, also Elementary Architectural Design.

Illustrating Mechanical Literature will appear in the February issue.

Many new inventions of interest to THE DRAFTSMAN's readers.

A New Rubber Stamp for Drawings.

Taylor Bros. of Cleveland have recently made a neat stamp for marking



tracing so to save the time of the draftsman in finishing a drawing.

The border line is $2\frac{3}{8}$"x$4\frac{1}{4}$" which is really large enough to enclose the data needed as a title. This firm furnish an "opaque ink" on pads for printing on tracing cloth with rubber stamps and will look after your orders carefully.

Transparent Paper.

THERE are several methods of rendering paper transparent. Coat white paper with a solution of Irish moss in water, to which a slight quantity of previously dissolved gelatine has been added. It should be applied hot to the paper. When colors are desired they must be transparent; they must be ground in varnish, and a stronger varnish is required than for opaque colors. A fine yellow may be produced by using yellow lake and red sienna. These make a warmer color than the yellow lake alone. If cost is no objection, aurasine may be used. For pale red, madder lakes should be employed, but for darker shades crimson lakes and scarlet cochineal lakes. The vivid geranium lake gives a magnificent shade, which, however, is not at all fast in sunlight. The most translucent blue will always be Berlin blue. For purple, madder purple is the most reliable color, but possesses little gloss. Luminous effects can be obtained with the assistance of aniline colors, but these are only of little permanence in transparencies. Light transparent green is hardly available. Recourse has to be taken to mixing Berlin blue with yellow lake or red sienna. Green chromic oxide may be used if its sober, cool tone has no disturbing influence. Almost all brown coloring bodies give transparent colors, but the most useful are madder lakes and burnt umber. Gray is produced by mixing purple-tone colors with suitable brown, but a gray color hardly ever occurs in transparent prints. Liquid siccative must always be added to the colors, otherwise the drying will occupy too much time. After the drying, the paper must be varnished on both sides. For this purpose a well-covering, quickly-drying, colorless, not too thick varnish must be used, which is elastic enough not to crack nor to break in bending.—English Mechanic.

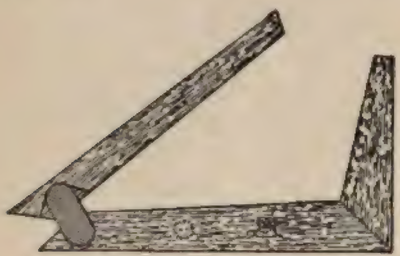
By a new Dutch process it is claimed that a moose hide can be turned into leather ready for the saddler's and shoemaker's use in from one to three days, while by following the usual method of preparation it takes about six months.

Metal Corrosion.

The corrosion of metals by sea water has been investigated by a German engineer named Diegel. Alloys of copper and nickel are not very rapidly corroded, and are rendered more immune by adjacent masses of copper alloys, iron or copper, these protectors being then more rapidly corroded. Copper-zinc alloys are corroded either by a uniform solution of the alloy from the surface, or, when the zinc exceeds 24 per cent., by a leaching out of the latter, but by the addition of 15 per cent. of nickel this action is prevented. The corrosion of copper pipes in vessels is often very rapid, and occurs frequently at bronze joints, but the experiments show that a high amount of arsenic (over five per cent.) in the metal greatly retards the decay. When two pieces of iron differing in phosphorus contents were in metallic connection the sea water corroded the low phosphorus iron from two to five times as fast as the other. The normal corrosion of single plates of metal was less as the percentage of nickel increased, and when two plates differing in nickel contained were in contact the plates higher in nickel was almost completely protected from corrosion.

The Duplex Angle.

The Duplex Angle is practically a right angle triangle with a movable



hypotenuse, the joint of which will retain, by friction, any angle to which it is set.

It is therefore, especially adapted for transferring a copying angles.

As the angle flush on both sides, it can be used for drawing equal angles in opposite directions, a great advantage in drawing roof pitches, teeth of gear wheels, sides of taper, arms of wheels, polygons, etc.

The Duplex Angle is one of the many useful instruments placed on the market by the Keuffel & Esser Co., 127 Fulton St., New York, who will be pleased to mail circulars and prices to our readers.

A New Rubber Substitute.

Gutta-joolatong is a comparatively new material which is utilized as a substitute for and in conjunction with india-rubber. It is a product of the East Indies, chiefly the island of Borneo, and in the form in which it is imported is described as "whitish in color, looking something like marshmallow candy, smelling strongly of petroleum and oxidizing on exposure to the air, becoming hard." The same description says: "It is not a substitute for gutta-percha or india-rubber, but is used chiefly as a filler in manufactures of india-rubber gum and gutta-percha." Its importation has increased from 6,500,000 pounds in 1899 to 14,000,000 pounds in 1903.

Cleveland Man's Big Job.

The task of a former Cleveland railroad man, Ira A. McCormick, formerly general manager of the Big Consolidated, in supervising the equipment of the New York Central tunnel from Mott Haven to the Grand Central station in New York city with electricity, promises to be one of the largest undertakings in electrical history. The plans of the company embrace an expenditure of about $10,000,000, and the equipment of the tunnel will require motor engines sufficient to move all the trains on the New York Central and New Haven roads from the Manhattan station to the Mott Haven station and the handling of the trains in the Manhattan yards. When the plans are worked out and completed the motors will take each train at the Mott Haven station to the Grand Central station and bring them back. The plan will do away with all smoke, gas and fumes and prove an innovation in railroad transportation in the congested districts. Mr. McCormick is experienced in electrical work and the success of the undertaking is practically assured.

"He Saw it on the News Stand"

Mr. Architect (angrily) "I'll wollop the hide off of that boy of mine for staying out late at night. I,ve warned him before about it. Here he comes now!"

Willie (hopelessly) "S—s—say paw here is a copy of "The Draftsman which I saw on the News Stand,"

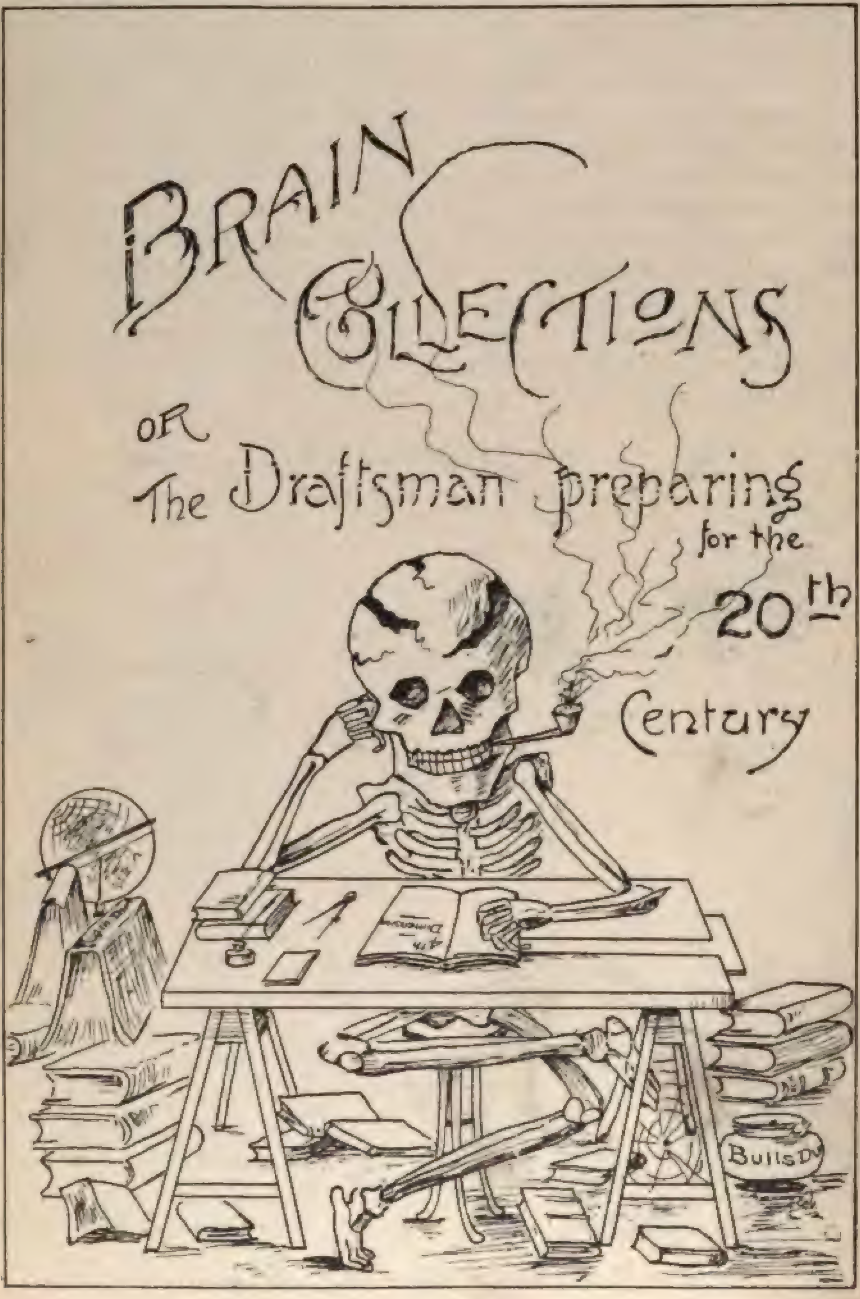
Architect (musingly) "Well—well ah, h,m er'e thank you my boy—thank you."

The $2,142,207 worth of platinum extracted in the Gorotiagodatski district of Russia last year is practically the world's supply of that metal.

A scheme has been prepared for carrying out an underground railway in Manchester, Englan, which connections with the principal out districts.

A Slur at the Profession.

Some artistic fellow makes up the following illustrations as the future of the draftsman but they will never come to this—they move to often, at least that is what some employes think the draftsman thinks he can do better



so he moves on to another job.

This may be his picture if he clings to old-time tools and methods. He should aspire to a better knowledge of the work (see Brain Collection)and to the use of the latest tools such as—well, we will say the Universal Drafting Machine.

Draftsmen do get thin studying, and the mental strain for eight hours is something to make a fellow nervous sometimes, too, yet the draftsman is the "man behind the gun" in one sense of the word.—he designs the gun.

Have you renewed your subscription for The Draftman? I'm just on my way to get the new January Issue, (See Scetch.)

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Mechanical Drawing at Central Institute.

MECHANICAL Drawing at Central Institute is being conducted as practical as possible and the work is arranged to cover a period of three years if desired.

During this time, the students also take up the subjects of mathematics, physics, chemistry and mechanics, besides drawing.

Day and evening classes occupy the same rooms, so that the tables in the two drawing rooms serve for a great number of students.

The tables for the use of students in drawing are illustrated on another page and it will be seen that they afford ample locker room as well as working space.

This illustration shows the room used by those in elementary drawing in both the day and evening classes

(Continued on page 93)

MECHANICAL.

Preliminary Propeller Design.

CARL H. CLARK.

THE questions of size, pitch, surface and shape of the blades of a propeller are among the most difficult of those with which the Marine Engineer has to deal. The conditions under which propellers work are so different that great care is required in judging the action of one wheel from that of another.

The problem as usually presented is about as follows: The I. H. P. required to drive any hull at a required speed may be at least approximately determined in several ways, and the question is to so proportion the propeller as to economically use up this power. For a nice determination of the properties of the wheel any authentic data may be used. This data has been collected and presented in tabular form in "Barnaby's Marine Propellers," and also in several other books and papers.

If this data is not at hand it is desirable to be able to make a close estimate of the properties of the propeller. The surface may be figured from the thrust per square foot of area. The indicated thrust is given by the formula

$$\frac{I.\ H.\ P. \times 33{,}000}{\text{speed in knots} \times 101.3} = \text{indicated thrust}$$

Now the amount of thrust absorbed by each square foot of blade area is from 900lbs. to 1100lbs.; so that if the I. H. P. is divided by this quantity the total blade area is obtained—this are must be so disposed as to diameter and number of blades, that the area shall not be too large in proportion to the disc area, or area of the circle described by the tips of the blades. The developed area is usually about 35 to 40 per cent. of the disc area, for four-bladed wheels and about 30 to 35 per cent. for three blades. This limitation will fix the diameter.

If the greatest immersed cross-section of the vessel is obtainable an additional estimate of the diameter is obtainable from the proportion of the disc area to the area of the greatest immersed cross-section. This proportion will be about 20 per cent. for slow vessels, about 33 per cent. for fast ships, and about 33 per cent. for vessels used for towing.

The revolutions per minute will be fixed by the I. H. P.; and, assuming that the given I. H. P. is sufficient to produce the given speed the pitch required can be readily figured, allowing a certain amount for slip. This slip in a well-designed propeller will vary between 12 per cent. and 20 per cent. with perhaps 16 per cent. as a fair average. Then—

Speed in knots $\times \frac{60\quad 80}{60}$ = speed in ft. per min.

$\frac{\text{feet per min.}}{\text{revs. per min.}}$ = advance per revolution

advance per rev.

$\frac{\text{advance per rev.}}{184}$ = pitch of wheel in ft.

The proportion of pitch to diameter, termed the pitch ratio, varies from 1.0 to 1.3. The final determination of these dimensions must be made such as to satisfy all the proportions reasonably well.

The above outlined method must be accompanied by practical experience, and when so used will give good results. The individual designer will usually have on hand a certain amount of data which he has collected from previous work. As a matter of fact it is not always possible to get the best propeller at the first trial, and many times it is necessary to make a second wheel, using the data obtained from the first, making whatever changes appear necessary.

The laying out of the propeller to the dimensions decided upon will be dealt with in the next issue.

The Allen Riveter.

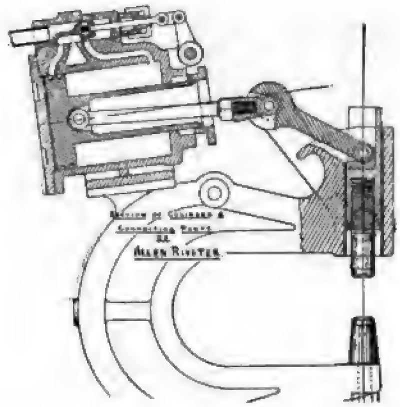
NO one of the modern improvements introduced into the structural, bridge and boiler making shops of this country deserves more attention at the present time than the portable riveting machine, a tool that is always reliable, is a great time-saver and one that can speedily accomplish work which it would otherwise be folly to undertake.

Prior to 1883 such a machine as a riveter was unknown, and it was at that time that Mr. Allen obtained the first patents on the machine, which has now come into such general use in boilermaking and structural iron working shops as to make one forget that it is a tool of comparatively recent invention. Since that date, the firm which bears his name has devoted its time to the perfection of his machine, and it now enjoys the reputation of embodying all the best principles of riveter construction with none of their defects. Several new features recently patented have now been added to the machine, which we shall attempt to describe in the space allotted.

As will be seen by referred to the illustrations, showing a sectional view and the machine complete, the piston rod connects levers of different length,

forming a toggle joint. The lower ends of the larger levers are attached to fixed centers on the frame, which is of very rigid construction, and the end of the short central lever is attached to the ram, which has a die head screwed into the lower end, this arrangement allowing any desired change in the distance between the dies to be easily effected.

The middle link is connected with the piston rod by means of a steel crosshead, which has a phosphor bronze shoe. The side links, which fit over the trunnions on the middle link, are connected by a straight pin. In this way a double bearing is obtained and a direct leverage effected of a



unique type in riveter design. Tests have determined that a 12-inch cylinder of this construction with 80 pounds pressure will exert 75 tons pressure on the head of the rivet.

One of the most important features is the cut-off contrivance, which automatically covers the port in the cylinder when the machine is not in operation, thus preventing any possible leakage of air.

The machines may be operated by either steam or air, and they are so balanced that when suspended they can be operated either vertically or horizontally. The "jaw" riveter is so arranged that it will straddle the edge of girders and beams, having 6-inch angle irons on each side, and likewise operate in channel iron.

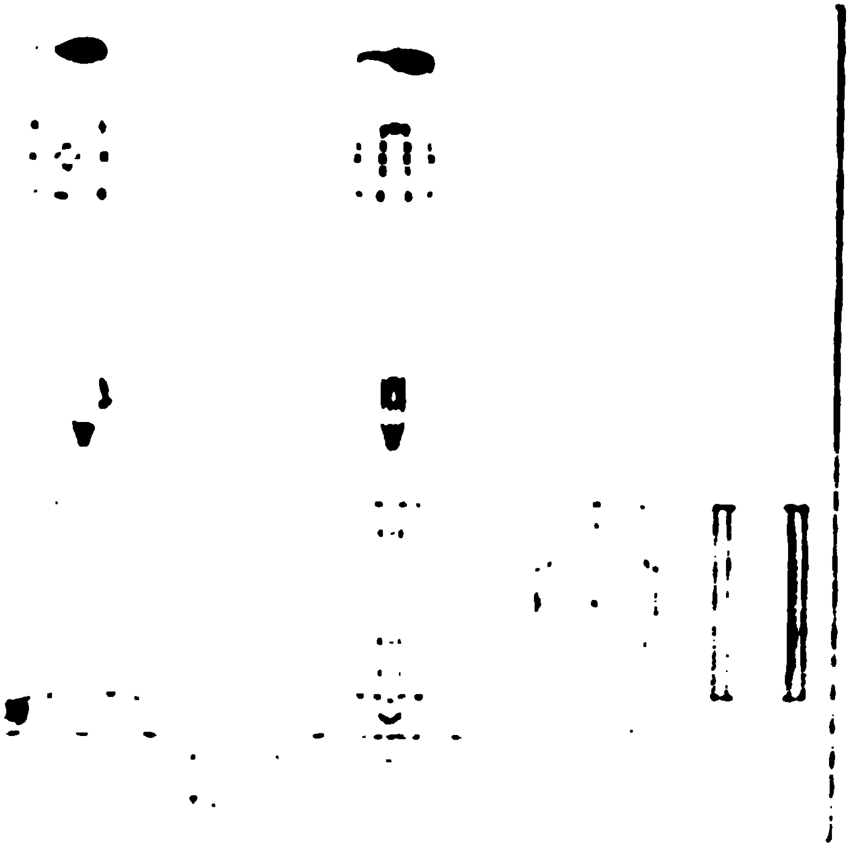
The Allen boiler riveter, which we also illustrate, consists of two levers, having at one end a pressure cylinder to open and close the levers, at the other end the riveting machine on one arm, and a suitable die with counter weight attached on the other arm. The long arms of the levers are made capable of reaching a rivet 72, 84 or 96 inches, respectively, from the edge of the plate, so as to operate upon the circular seams of a boiler.

The riveter works on the principle of hand work, forming the head of the rivet by a succession of rapid blows around the rivet until the desired shape of the head is obtained.

The machine is operated with an atmospheric pressure of from 30 to 40 pounds to the square inch, and makes from 150 to 200 strokes per minute. The time required to form the head of a ¾-inch rivet is about 6 seconds, and at steady, straight work, allowing for ordinary detention and loss of time, two or three rivets can readily be finished in one minute.

These machines are operated with less than half the number of men required to run a riveting machine where the work is suspended, and their simplicity makes skilled labor entirely unnecessary. — *"Ryerson's Monthly."*

Rig for Slotting Oil Grooves



guide which throws it forward to the required depth. One stroke only of the head is necessary to complete the cut.

H. MacDonald.

Elementary Mechanics and Lever Design.

A MACHINE is a device designed to transform and convey energy, and to do useful work.

An electrical power plant illustrates both features of a useful machine or collection of machines.

The heat energy of the steam actuates the moving parts of the engine which transfers the power to the armature of the dynamo, where it is converted into the energy of the electric current.

The effect force exerted by the agent losing energy and the force exerted by the body receiving energy in a simple machine may be denoted by two terms introduced by Rankine, namely *effort* and *resistance*. The problem in simple mechanics consists in finding the relation of resistance to effort and this relation or ratio is known as the *mechanical advantage*.

In elementary discussions, it is customary to neglect friction and to assume that the parts of a machine are rigid and without weight, but in practice there is always some wasteful resistance due to friction, rigidity of cords, etc. The work done is therefore always partly *useful* and partly *wasteful*.

If a machine could be made that would waste no energy, that is, one in which the resistance is all *useful* and not *wasteful*, the machine would be perfect and its *efficiency* would be unity.

The efficiency of a machine is the ratio of the useful work done by it to the total work done by it, and is always expressed as a percentage.

An efficiency of 90 per cent. means that the energy given out is 90 per cent. of that put into the machine.

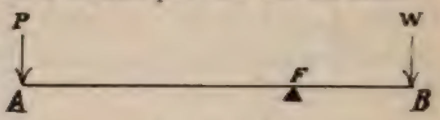


Fig. 1.

Fig. 2.

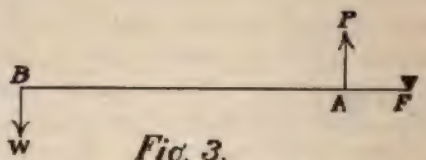


Fig. 3.

A machine which will give perpetual motion with no supply of energy from without is thus clearly impossible.

Simple machines are restricted to devices for merely transferring energy while *complex machines* areoften combinations of two or more simple machines or *mechanical powers*.

There are only six devices consid-

ered as simple machines, the *lever*, the *pulley*, the *wheel* and *axle*, the *incline plane*, the *wedge* and the *screw*. The pulley and wheel and axle are levers in different forms and the wedge and screw are modifications of the inclined plane; it is therefore possible to reduce the six to two, the *lever* and the *inclined plane*.

A *lever* is a rigid bar straight or curved, turning about a fixed center called the *fulcrum*.

The perpendicular distance between the fulcrum and the line of action of the effort and between the fulcrum and the resistance are called the *arms* of the lever as AF and FB in Fig. 1.

A straight lever is one in which the arms are in the same straight line.

A lever is said to be of the first class if the fulcrum is between the points of application of the force or effort and the resistance, Fig. 1; of the *second class* if the resistance or weight is between the fulcrum and the effort (Fig. 2); and of the *third class* when the effort is between the resistance and the fulcrum, (Fig. 3.)

The *common balance* is an example of the first class, equal arms, while the crow bar resting over a block with a weight at the outer end is of the same class, though of unequal arms.

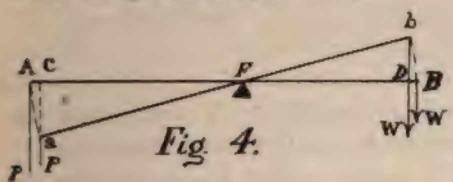
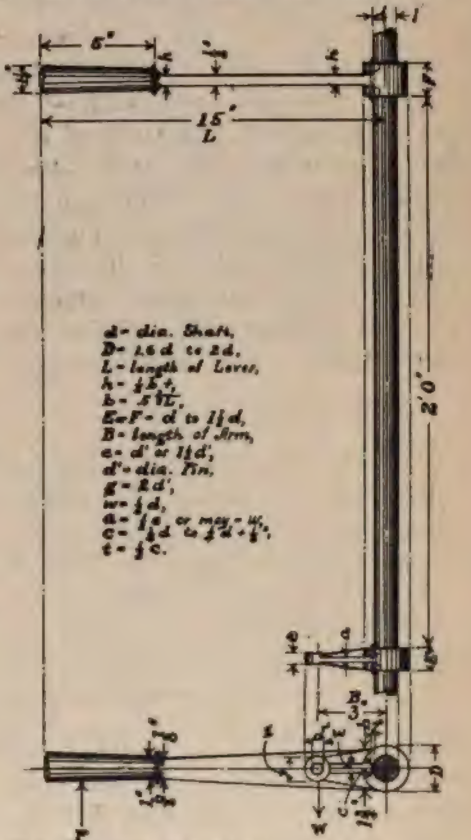


Fig. 4.

To demonstrate the *mechanical advantage* of the lever, let *AB* (Fig. 4) be a straight lever whose arms are *FA* &*FB* with *P* the effort and *W* the resistance or weight lifted. Tilt the lever into the position *aFb*, and neglecting friction of $P \times aC$ (effort multiplied by distance through which it moves) is the work done by the effort against $W \times bD$ of the resistance, $W \times bD$ being the weight multiplied by the distance through which it is moved.

Putting these equal to each other, $P \times aC = W \times bD$ but the ratio of the lines *aC* and *bD* is the same as that of the arcs *aA* and *bB*; and the ratio of the axes is the same as their radii



FA and *FB*, therefore

$$P \times FA = W \times FB$$

The arm *FB* is often spoken of as the *purchase* that lever has and is applied to levers of the first class.

Suppose we say a man weighing 160 lbs works with a 6 ft. crowbar and

used a fulcrum six inches from the end, what weight can he lift?

Then PA=5 ft.-6 in.=66 ft. FB=6 ft. P=160lbs.

160×66in.=K×6in.

10560=W×6.

$$W = \frac{10560}{6} = 1760 \text{ lbs.}$$

Now suppose we are to design a lever with which a man who can lift 100 lbs. can lift 500 at the end of an arm 3 in. from the center of the shaft, the arm and lever to be 2 ft. 0 in. apart.

Then Fig. 5 shows the arrangement of lever and arm with a table of proportions. Some of these are revised from Union's Machine Design, though it is suggested that *D* be twice the diameter of the shaft if the arm and lever are of cast iron and if so then ribs should be run along on the web of the lever to stiffen it.

The grip portion of the lever will be the same for any length if it is to be for the hand.

High Speed Cams.

By F. H. Sibley.

CAMS might be divided, with respect to their method of transmuting motion, into two classes—those in which the follower is a point, or a roller mounted on a pin as an axis, and those in which the follower is a bar or yoke, either straight or curved. Each of these divisions might be subdivided into two classes with respect to their use, into cams that are designed to work at low speeds and cams that are intended for high speeds. The operating machinery of some types of drawbridges, and metal shaping machines furnish examples of the first subdivision, sewing machines contain a good illustration of the second.

Cams are made in a great variety of shapes. For the method of laying out some of the more common forms, the student is referred to the standard text-books of Mechanism or to the other articles of this series.

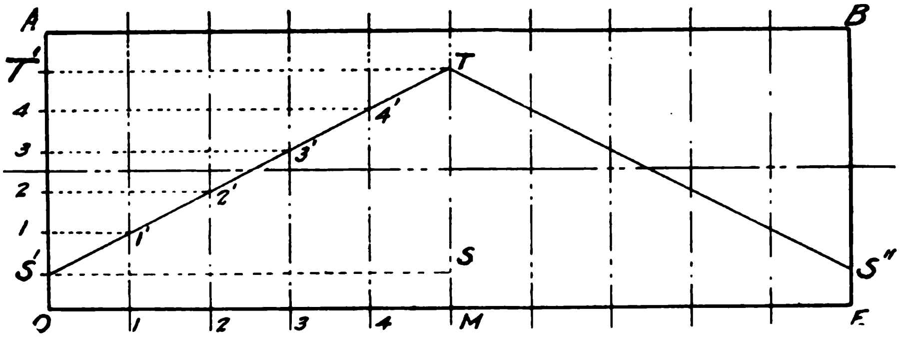


Fig. 1

Cams that are intented for high speeds should be so constructed as to give a smooth motion to a follower, i. e., a motion free from jerks due to sudden starting and stopping. The principle on which they are designed is, that as the cam rotates the follower shall start gradually from rest, increase to a maximum velocity at the middle of its stroke and then gradu-

ally come to rest again. The motion is uniformly accelerated during the first half of the stroke and uniformly retarded during the last half of the stroke. The method of laying out the curves for high speed cams will be applied in this article, 1st to a cylindrical cam having a roller follower mounted on an arm which oscillates about a fixed center (Fig. 4). 2nd to a plate cam having a bar follower, which moves so as to remain always parallel to its initial position. Fig. 5.

In uniformly accelerated motion, the distance passed over by a moving point varies as the square of the time it is in motion, i. e., if a point moves one inch the first second it will move four inches in two seconds, nine inches in three seconds, etc. If these values were plotted with reference to a pair of co-ordinate axes the resulting curve would be parabolic. This, therefore, is the form of the curve for a high speed cam.

Suppose we take a sheet of paper *OABE* (Fig. 1) and lay out on it a line constructed as follows: Bisect *OE* at *M* and divide *OM* into any convenient number of parts, say 5. On the perpendicular through *M* lay off any distance as *ST* and divide it into the same number of parts as *OM*. Through the divisions 1, 2, 3, etc., on *OM* erect perpendiculars and through the divisions 1, 2, 3, etc., of *S'T'* draw parallels to *OM*. Then through 1', 2', etc., the intersections of these two sets of lines draw *S'T*. The line *TS"* would be constructed in the same way on the other side of *MT*. Now if the sheet of paper were wrapped around a cylinder (as shown in Fig. 2) whose circumference is equal to *OE*, and the cylinder made to revolve on its axis, a point forced to follow the path *S' TS"* would move up a distance *ST*, while the cylinder was turning half around

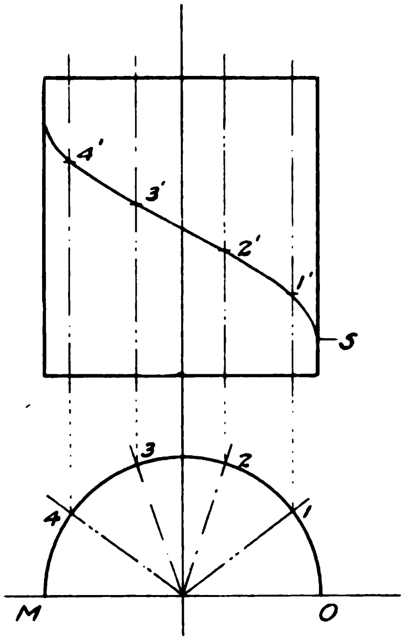


Fig 2

and then down again to where it started as the cylinder completed its revolution. The following point would have the same velocity throughout its motion. It would go from rest to its maximum velocity with a sudden jerk and get another jerk at the top of the cylinder where it turned to come down. Such a motion would be very trying on a machine particularly if the reversals took place rapidly.

Suppose now that the path of the follower on the cylinder, instead of being a straight line wrapped around the cylinder is made a parabolic curve reversing at 3'. Fig. 3. Then if this curve is wrapped around the cylinder

as shown in Fig. 4 a follower moving along this path will start gradually from S', increase to a maximum velocity at 3' and then come gradually to rest again at T, while the cylinder revolves thro an angle of 180° From T to S'' while the cylinder revolves the remaining 180° the motion of the follower will be reversed coming to rest again at the original starting point.

The method of laying out this curve is as follows: In Fig. 3, lay off OM equal one half the circumference of the cylinder. Bisect OM at 3, and $S'T'$ at $9b$. Divide $O3$ into any convenient, number of parts say 3. Then divide S' $9b$ into the square of three parts as shown. Erect the perpendiculars at 1, 2, 3, and draw the horizontals through $1b$, $4b$, and $9b$. The intersections 1', 2', 3' will be points on the curve. Now divide $3M$ into three parts and the distance T' $9b$ into the square of three parts and get the intersections 1", 2" and complete the curve from 3' to T through these points. The curve TS'' corresponding to the second half of the cylinder's revolution is laid out in the same way. This curve can be found in Fig. 4 by projection, as shown at ST. If two more curves are drawn parallel to this one and at a distance apart equal to the diameter of the following roller, they will represent the sides of a groove which will drive the follower vertically up and down the required distance according to the law of the high speed cam.

In this example the follower is mounted on an arm which oscillates about Q, therefore the follower, moves up and down on the arc PP' instead of on a vertical line. Then points on the curve TS instead of being found on the vertical lines as shown will be offset by distances equal to the ordinates of the arc PP'. The right hand half of Fig. 3 shows the construction for finding the true point. The true curve is the lower line in the middle of the groove in Fig. 4.

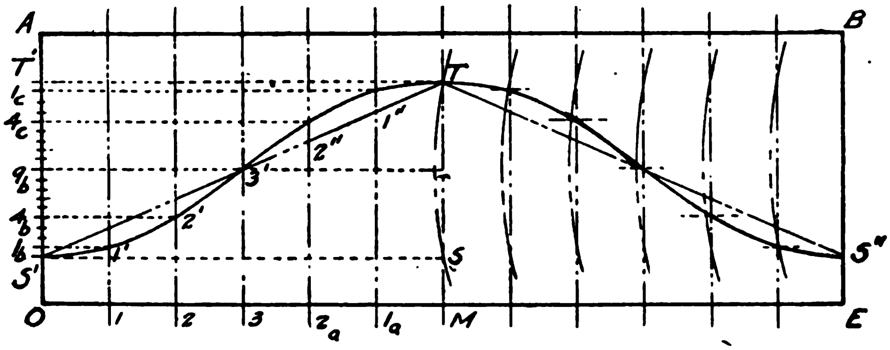


Fig 3

Now consider the plate cam having a bar follower in Fig. 5, O is the center of the base circle of a plate cam which by revolving about O will drive the bar B upwards from A to T with uniformly accelerated and retarded motion while the cam is revolving thro' an angle of 120°, hold it at rest at T while the cam revolves another 120° and then let it fall to its original position as the cam completes its revolution. The motion

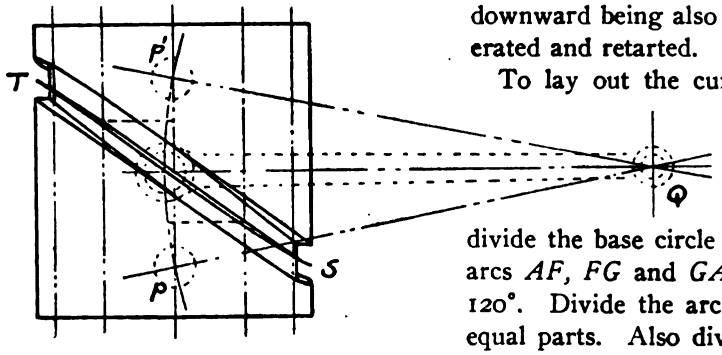


Fig. 4

downward being also uniformly accelerated and retarted.

To lay out the curve of this cam, divide the base circle into three equal arcs AF, FG and GA each equal to 120°. Divide the arc AF into two equal parts. Also divide the distance AT into two equal parts at 9a. Divide

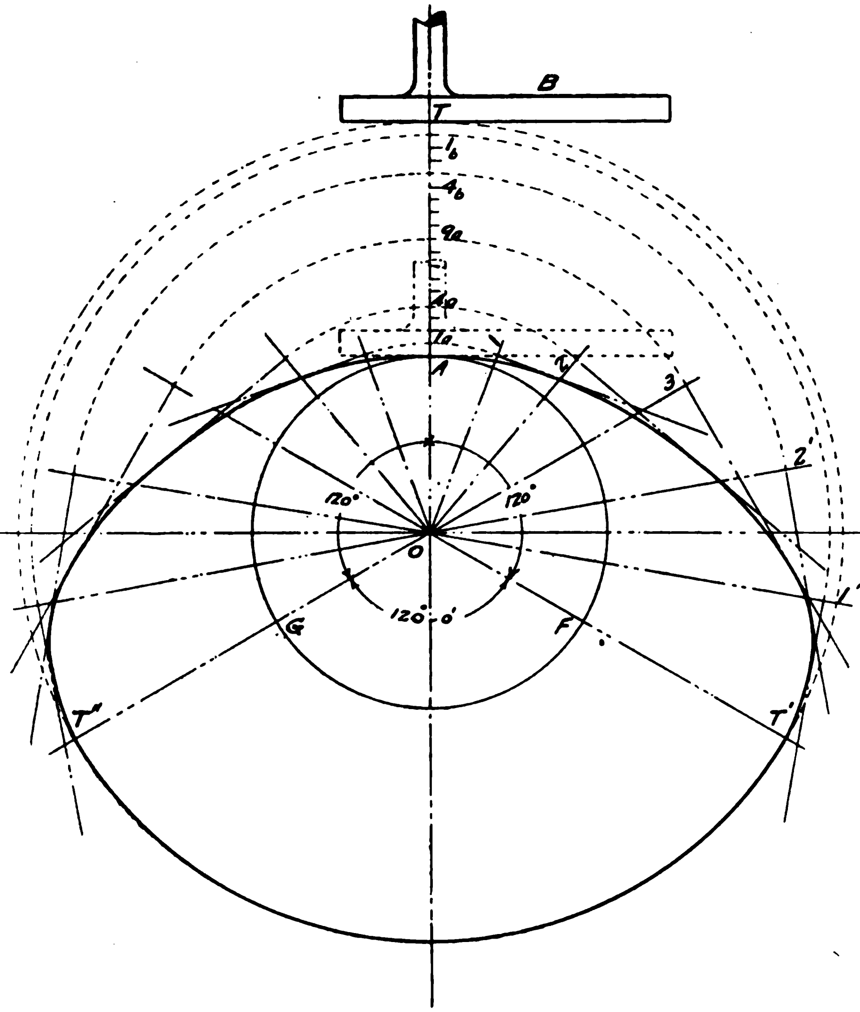


Fig. 5

the first half of the arc AF into any convenient number of parts, say three, and draw the radii $O1$, $O2$, $O3$. Lay off the distance $A9a$ into the square of three parts or nine. With O as a center and radii $O1a$, $O4a$, $O9a$, draw arcs cutting the radii to the base circle in the points 1, 2, 3. At these points draw lines making the same angle with the corresponding radius as the bar B makes with the original position of the radius OA. In this case the angle is constant and equals 90° since we have assumed that the follower is to remain parallel to its initial position, but if the bar were hinged so as to oscillate about some point off at the side of the figure, the point T on the bar would move in the arc of a circle and the angle would change with every new position of the cam. Now divide the second half of the arc AF into three parts, also divide $T9a$ into nine parts. With center at O lay off OT' equal to OT, $O1$, equal to $O1b$, $O2'$ equal to $O4b$. Draw perpendiculars to the radii through these points as before. A smooth curve drawn tangent to these perpendiculars will be the required curve of the cam and as the base circle revolves about O the bar will move upward from A to $9a$ with uniformly accelerated motion and then from $9a$ to T with uniformly retarded motion.

For the period of rest the curve is simply the arc of a circle with radius OT. The curve AT'' is laid out exactly like AT'.

It will be noticed that the curve does not pass through the points 1, 2, 3, 2', etc., but tangent to the lines drawn through those points. The reasons for this can be found in the text-books under the ordinary forms of cams of this class or under the subject of rolling and sliding contact.

In Place of the Atom.

If we must discard the atom what are we to accept in its place? Two new conceptions have been found necessary—the "ion" as the unit of matter, the "electron" as the unit of force. The new chemistry holds that matter and force are different manifestations of the same thing. Inertia is the characteristic; indeed, the indispensable, property of both matter and electricity. What would be simpler than to assume that the ultimate particles of each are one and the same? Prof. Fleming has declared that "we can no more have anything which can be called electricity apart from corpuscles than we can have momentum apart from matter."

Percussion System.

In the percussion system of mining the great boring instrument or trepan, rises and falls with a regular motion, revolving as it does on a vertical axis. Its huge teeth tear and grind the soil and rock to powder. The water in the shaft turns this to pulp and the mixture is brought to the surface in a huge caisson with an automatically sliding bottom. When the shaft is lined with steel tubing, it is pumped dry, and when a relief shaft is sunk the mine is ready for operation. This method is being used to reach a newly discovered seam of coal, which was struck at a depth of 1,190 feet in Kent, England.

ARCHITECTURAL.

Cost of Operating Buildings.

EXPRESSING the cost of operating buildings in terms of the rentable floor space is unusual, certainly so far as most of the published data on the subject are concerned. It will therefore be of interest to record the results of some investigations recently made of a number of New York buildings, particularly as figures on this basis are valuable as indicating possibilities of comparison between buildings of the same as well as of different classes. The data were compiled from actual running expenses by Mr. J. D. Wilson, treasurer and mechanical engineer of the American Elevator Company, of New York, and cover both office and loft buildings.

Of the office buildings selected one is located on Broadway and is fifteen stories in height, having about 56,900 square feet of rentable area, including space in basement and attic. The building has its own lighting, heating and elevator plant, the latter of the hydraulic type, and the operating cost, on the basis of the bills incurred in 1901, was 35 cents per square foot of rentable space. When insurance, water rents and similar charges are included, the cost was 65.1 cents and 70.2 cents including maintenance, indicating that the maintenance charge was something over 7.8 per cent. In the case of a second office building, in what is regarded as the uptown, office-building section, having over 18,500 square feet of renting space, the net operating cost was $1.25 per square foot per annum, but, including taxes, was $1.42. The maintainance charge was 23 cents, or 16.2 per cent., making the total $1.65. This building has electrically operated elevators and pumps and the current is furnished from an adjacent plant. The difference in operating costs in the two buildings is in part due to the difference in size.

In the case of the down-town building, Mr. Wilson made a subdivision of the costs, which, though largely based on estimates, is interesting. The cost of the lighting service alone was obtained in the following manner: From a twenty-hour test during the winter, the output of the electric plant was found to be 576.9 kilowatt-hours, the average load being 258.4 amperes at 112 volts. By allowing 8 pounds of coal per kilowatt-hour, the coal consumption chargeable to light was, as readily calculated, 2.31 tons. This amount, however, he assumed as the average daily amount burned during the six months of the winter season, and for the consumption during the other half of the year, when less light-

ing is required, made a reduction of 40 per cent., leaving the figure 1.39 tons. These two amounts into a half year in each case, with coal at $2.77 per ton, the price then current, gave the total coal bill for lighting service as $1,-872.46. It happened that the amount of coal represented by this cost was about one-third of the total amount burned and accordingly one-third of the engineering charges of the building, such as labor, water, taxes, insurance and supplies, or $1,579.84, was added. To this was then included the cost of work done in electric equipment and maintenance, $473.42, and the cost of lamp renewals in one year $80, making the total cost of lighting $4,005.72. There were 1,667 16-candle-power equivalents in the building, so that the cost per 16-candle-power equivalent was $2.41, or, if interest at 6 per cent. were included, $2.54. One 16-candle-power equivalent was furnished for every 34 square feet of rentable floor space, but if some 200 lamps used for public lighting were excluded, there was one equivalent for every 38.5 square feet. The difference between the total coal consumed in one year, 1,596.6 tons, and the amount used for lighting, was charged to pumping, namely, 920.4 tons. Of this, 25 per cent. was regarded as required for miscellaneous pumping, leaving 691.3 tons for the elevators. There are four passenger elevators which travel at a speed of 450 feet per minute and were found to make an average of 304 round trips per day, carrying 4,500 passengers. They approximated on this basis 76.4 miles per day, or 22,900 car-miles per year of 300 days, allowing for days of light operation, such as Sundays and holidays. The coal cost, at $2.77 per ton, was $1,914.94, or 83.5 cents per car mile. To this were added $3,159.-68, the remainder of the engineering account; $3,276, the wages of the elevator operators and starters; and $272.20, the cost of elevator repairs; that is, a total of $8,622.82, or $3.77 per car mile on the basis of 300 days, or $3.09 on the basis of 365 days.

The loft building, though furnishing power to the tenants, has a cost of operation that is very low in comparison with the office building, indicating the increased cost ratio of the conveniences of the modern office structure. One loft building, having 88,410 square feet of rentable space, cost for operation, 13.4 cents per square foot per annum, or 14.4 cents if maintenance charges were included. Another having 132,938 square feet of renting area and 2,027,000 cubic feet of contents, cost for operation 16.9 cents, or, including maintenance, 17.8 cents. In this buildng live steam is supplied for heating and feed water is introduced into the boilers without heating. Here the coal, oil, supplies and repairs cost $3,173; taxes, insurance and water, etc., $16,578; and labor, $3,963. A third loft building having 84,796 square feet of floor area, of which 75,198 is rentable, and 1,526,000 cubic feet of contents, cost 17.9 cents per square foot, including repairs. No electric light was furnished, nor high speed elevator service, and there was no janitor. The coal, oil and repair account amounted to $2,261; insurance, taxes and water to $9,132; and labor to $2,040. A fourth loft building, of a high class,

Relation of Window-Area to Floor Space

structed lighting surface.

(2) The proportion between the height of the window-tops and the depth of the room lighted should be at least 500 to 1,000, or, in other words, the distance from the floor to the window-tops should be one-half the depth of the room to be lighted.

These figures support the old principle that "top-light" is the best; the nearer the window-tops come to the ceiling the more efficient will be the lighting to be secured from a given surface. Care should be taken that overhanging lintels be not allowed to obstruct the light.—*"Keith's Magazine."*

Beam is Powerful.

WEDNESDAY afternoon at the new Lyric theater occurred a test of a comparatively new style of beam which has been placed in the theater for the support of the balcony, the test being witnessed by a large number of interested architects and builders who were attracted by the anannouncement that the supreme test would be administered to the beam.

The feature of the beam is that instead of being constructed of steel, as is usually the case, it is constructed almost wholly of concrete of an extra fine quality. In addition to the concrete and for the purpose of bracing it, a number of steel rods 1½ inches in diameter were scattered through the beam; some the entire length, some four-fifths the length and some only through the central portion. The beam is 55 feet long and supports the entire balcony of the theater without a column on the center to obstruct the sight of the people who may happen to sit at the rear of the first floor. It is 5 feet deep and 12 inches in width and by means of bolts driven into the concrete when the material was soft, the wooden flooring and girders are held in their proper positions.

The test was a pronounced success in every way and proved the practicability of the system of concrete construction. The contract under which the beam was constructed called for a test of seventy-five tons on the entire length of the beam and by means of a chain swing and a heavy wooden platform, a weight of over forty-four tons was swung on a space in the center seven feet in length. With this enormous weight, the deflection of the beam, calculated by minute measurements, was but nineteen-thirty-seconds of an inch, a deflection of over an inch and a half being necessary before the outward condition would give evidence of the strain. The beam rests on its own foundation and is supported at each end by its own columns, making its construction such that the entire building could be removed from about it and the beam would still remain standing. The weight placed on it yesterday was in the form of pigs of iron and constituted a load equal to 2,544 pounds per lineal foot. The weight of the largest locomotive used on the railroads running into Cleveland is but 2,500 pounds per lineal foot, affording a comparison by which to estimate the great strain the beam was under.

The building of concrete beams of the character of that just completed has been almost unknown and the one in the Lyric theater is, so far as known, the largest in the United States. The architects who were present and the members of the board of management of the theater expressed themselves as very well pleased with the test. The architect of the theater is Frederick William Striebinger.

A Very Convenient Triangle.

ENCLOSED find sketch of a celluloid triangle, which might interest the readers of The Draftsman and that which any draftsman might construct.

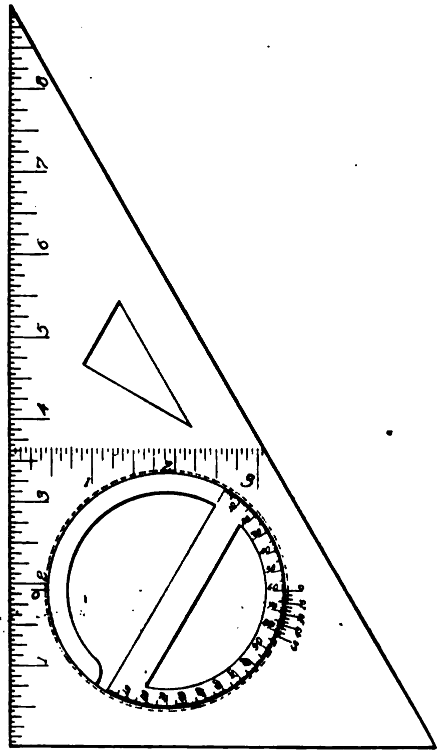
The inches are graduated on the lower side, and by moving the tee square up or down lines may be scaled and drawn at the same time, thus avoiding so much erasing as we are accustomed to do.

Vertical lines up to three inches apart can be drawn very accurate.

The protractor, though very small, is quite useful. This part can be purchased at any dealer of draftsmen's supplies, the edge leveled and sprung into place.

If others will adopt this plan, they will find it very useful.

E. A. CHAMBERLIN.



The Greatest Ocean Depth.

The deepest spots in the Mediterranean are said to be only 14,000 feet, while the bottom of the Atlantic Ocean is said to have but few places deeper than 21,000 feet. Altogether there are forty-three spots of greater depth known, of which twenty-four occur in the Pacific, fifteen in the Atlantic, three in the Indian Ocean and one in the South Polar Sea. The deepest thus far known spot in the ocean is that known as Aldrick Death, to the east of the Kermadec Isles, in the southern part of the Pacific Ocean, to the northeast of New Zealand, with a depth of 32,058 feet.

STRUCTURAL.

Notes on Shop Inspection.

C. J. Tilden, C. E.

IN structural steel shops the inspector is often called on to suggest remedies or alterations from the original working drawings. Of course no deviation from the drawing should be allowed unless absolutely necessary, but occasions sometimes arise when when serious delay would result from too strict adherence to the drawing.

Suppose, for example, a shop is building a number of plate and angle columns having the cross-section shown in Figure 1. The material for

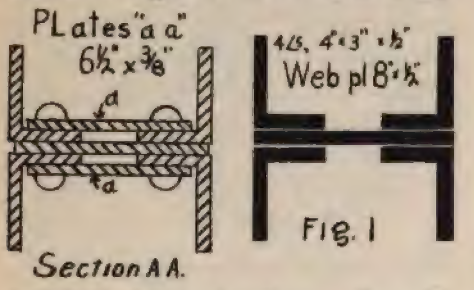


Fig. 1

these has been ordered from the mill, and is supposedly sheared to the length required. When the columns are riveted up it may happen that one of the web plates is short, so that the top of the column appears like Figure 2. To wait for a new plate to come from the mill would be out of the question, as it might hold up the erecting gang in the field indefinitely. It would be possible, perhaps, to take a new plate out of stock on hand at the shop; but to cut out all the web rivets and replace the plate would be a tedious and expensive task. What, then, is the quickest and best way out of the difficulty?

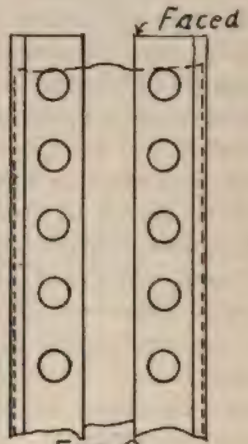


Fig 2

If a cap plate is to be used (as is nearly always the case) between this length of column and the length next above, the top of the column may be planed down until the full section appears on the faced end, and the cap plate made correspondingly thick to bring the column up to the required length. This, of course, generally precludes the use of a single rolled steel plate for a cap, as the thickness required would be too great. To use two or more thinner plates would be bad practice, as

it would be almost impossible, with sheared plates, at least, to get them suffciently even to insure good bearing surfaces between adjacent plates. If this expedient is resorted to, therefore, the inspector should insist on a cast cap plate, accurately planed to the required thickness.

If the web is so short that planing down the end of the column would bring the faced end too near the web rivets, or if, for any reason, it is essential to keep the faced length of the column unchanged, a different solution of the problem must be sought. Instead of planing the column down until the full section is secured, it may be built up, as shown in Figure 3, un-

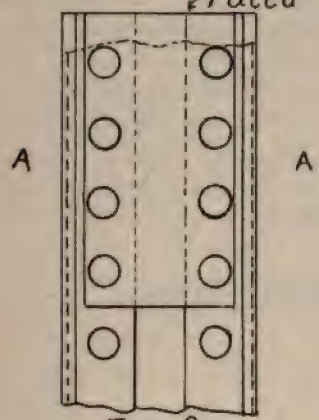


Fig 3

til the section lost in the web is made up by the two outside plates, *AA* riveted to the web of the column outside the flange angles. The problem for the inspector then becomes one of design, i. e., to determine the proper size of these reinforce plates and the number of rivets required to hold them, and to solve it exactly he should know just what unit stresses have been assumed by the designing engineer in proportioning the columns. An exact solution, however, is of little value in a case like this; an approximate solution, quickly reached, is what is wanted, with one proviso, viz., that the necessary assumptions shall be so made that any error in result will be on the safe side. The designer of the column probably used 12,000 pounds or 16,000 pounds "reduced," as his allowable compressive stress per square inch in computing the columns sections, i. e., say, 12,000 pounds per square inch for short columns, reducing this allowable stress as the unsupported length of column increases in accordance with some approved column formula. If, then, the inspector uses 10,000 pounds per square inch as the allowable unit stress, he can be fairly sure of being well within the limits of safety. If the web plate is 8 inches by ½ inch, that is, has a sectional area of 4 square inches, or, at the assumed unit stress, is capable of supporting 40,000 pounds safely, and it is to be reinforced where the deficient by two plates 6½ inches wide, each plate should have an area of 2 square inches. A plate 6½ by 5-16 inch has a sectional area of 2.03 square inches, just sufficient to fulfill the requirements, but to be surely on the safe side it is better to use ⅜-inch metal; two plates 6½ inches by ⅜ inch have an area equal to 2 by 2.44= 4.88 square inches. Since these two plates virtually place the web of the column at the point where it is defective, they must together carry the entire load assigned to the web, or 40,000 pounds, so each plate must be capable of supporting safely 20,000 pounds. If the rivets are ¾ inch in diameter, each rivet will carry 3,300 pounds in

single shear (assuming 7,500 pounds per square inch as a safe shearing stress for rivet steel); consequently, for 20,000 pounds load, seven rivets will be required. For the sake of symmetry, eight are used, and the appearance of the reinforced column will be as in Figure 3.

The reinforce plates should, if possible, be riveted on before the column is "faced" or planed for bearing. Generally, however, the defect in the web plate would not be noticed until after the column had been faced; the reinforce plates must then be sheared ¼ inch or ⅜ inch long, and the column again put through the machine to bring the entire section to an even bearing.—*"Ryerson's Monthly."*

New Industry Begun.

The manufacture of steel mine ventilators is a new departure at the Monongahela Manufacturing Company's plant. The device was invented and patented by Charles Kuderer, who is associated with the company. It is the result of years' of experience with mine ventilators and is based on the most approved and recent scientific investigation.

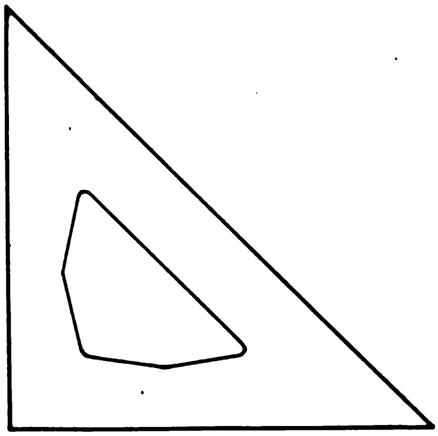
Unlike the old ventilators of wood, it is constructed entirely of steel and its general design embraces the best practical principles.

The ventilators will be made on the duplicate interchangeable part system and will be shipped to all parts of the world where mine ventilators are used. Leading mining companies are welcoming Mr. Kuderer's invention.

The company will manufacture the ventilators in sizes from 4 to 25 feet in diameter. The 20-foot machines will generate 400,000 cubic feet of air per minute at 3 7-10 inches of water gauge. The steel construction insures safety at high rotative speeds ranging from 10 to 1,000 revolutions per minute. The new plant is at Monongahela City, Pa.

A Triangle for Structural Shapes.

Though not new, it is a good idea to cut one's triangle as shown to give the angle of the base of T-rails and rolled shapes such as channels and I beams. The angle of the flange of a rail with its bottom is 13°, but the taper on the flanges of channels and I beams is 2 inches in one foot. Lay off a horizontal line with the tee-square, then measure 12 inches along it from a point and then vertically 1 inch, completing the triangle with a sloping line.



Cut out one side of the center oppening to fit this line and the other side for 13°

ILLUSTRATING.

The Art and Invention of Letter Design—Its Beginning and its Uses.

By Charles C. Riester.

THE art of invention which perpetuates the history and achievements of all the arts and sciences has been contested unceasingly. This, however, should not be surprising when we consider that the inventive instinct of the human race is everlastingly striving to bring before the public new ideas, new designs and inventions which marks the progress of universal ingenuity. One of the greatest benevolences is the invention and discovery of printing, that is, to make designs in a movable body so as to make each body a letter.

For four centuries the controversy has raged without giving up its mysterious origin. Volumes have been written, lives have been spent, fortunes have been wasted, communities have been stirred, a literature has been developed, to find an answer to this mysterious question: "When, where and by whom was found out this masterful art of printing books?" And yet the world today is little nearer a finite answer to the question of the greatest and most cultivating discoveries, namely, the invention of printing books. Indeed, the dust of battles has added to, rather than diminished, the mysterious clouds which envelope the problem, and we are tempted to seek refuge in an agnosticism which almost refuses to believe that printing ever had an inventor. But, meanwhile, it is possible to avail ourselves of whatever evidence exists as to the nature of the letters, and as to the methods by which those letters were produced, and possibly to arrive at some conclusion respecting the earliest practices of the art.

However, there is a legend of the invention of this art, as far back as the beginning of the 14th century, of a man, Laurentius Joannes, surnamed Aeditus or Custor. To this man should revert the wrested honor of the invention of the art which has been wrongfully enjoyed by others. A just judgment should give to him before all others the laurel which he has deserved as the most successful.

While strolling in the woods near the city, as a citizen who enjoyed ease and time, it happened that he undertook as an experiment to fashion the bark of a beech tree in the form of letters.

The letters so made, he impressed the reverse way consecutively upon a

enough to correspond with the bold face of the I. This letter was used in all the works of Sorbonne press, but when Gehring left the Sarbonne and established himself at Soleil d'Or, in 1473, he made use of the Gothic letter, which is illustrated in Fig. 5.

FIG. 6

These specimens in initial and page ornaments and embellishments, which when put in with neat designs, leaves, acorns, grapes, roses can be worked in to good advantage as will be seen in Fig. 6.

These designs can also be used in architectural work, such as wall paneling, ceiling decorations, etc., which will be illustrated in the next number of this magazine.

Five Toasts.

The Russian—"Here's to the stars and bars of Russia that were never pulled down."

The Turk—"Here's to the rulers of Turkey, whose wings were never clipped."

The Frenchman—"Here's to the cock of France, whose feathers were never picked."

The American—"Here's to the stars and stripes of the United States of America, never trailed in defeat."

The Englishman—"Here's to the rampin', roarin' lion of Great Britain, that tore down the stars and bars of Russia, clipped the wings of Turkey, picked the feathers off the cock of France, and ran like h—l from the stars and stripes of the United States of America."

It has been said that a man with brains does not have to work. A more correct statement would be that anybody who has original ideas of benefit to humanity can always find a market for them. The trouble with most people is that they are running in a groove. There is a wide and rich field open to anybody who will step out of the groove and do something "different."

were used in Italy, from thence the Roman letter was used throughout Europe. In Fig. 3 you will see the Roman letter, both as where used in initial lettering, and the regular script.

The work and toil of cutting these letters involved in the first undertaking was very painful to trace all of the characters and figures, the reversed way, so as when imprinted on the sheet made it readable. This was scarcely less tedious than copying the required number by the deft pen of a scribe, who were few in number at that time, although at the present time

FIG. 4

there are considerable able designers and sketch artists who make the self-same designs as were then in vogue.

The Roman letter was the first style used in France, in the year 1470. It was a handsome round style, with a slight suggestion of Gothic in some

FIG. 5

of the letters. Gehring, a German, and his associates designed from the best available models and the entire alphabet was without initials. The authority was Chevilliers, on initial letters regarding the capital, for which blank spaces were left to be filled in by hand.

In Fig. 4 you will see the letter I set into a plate of embellishments, or back ground which is made heavy

This same line of argument can be applied with the same measure to all other branches of art work. There are too many so-called cartoonists in the country, who do nothing more than copy from the work of others. They make a selection of an idea from some other person's work, and by changing it a little here, a little there, they adapt it to their own needs and thus it passes inspection. But the artist, like the school-boy who uses "ponies" in his examination, has cheated himself and not his teacher or the public. He believes he has passed examination and prides himself on the fact that he has deceived others into the belief as to his ability to do original work. But what happens when he is called upon for a "little out of the ordinary?" What does the artist (?) do then? Usually he copies again, and endeavors to palm off somebody else's ideas, perhaps not half as good as his own would be, and he has lost another opportunity to step up into the field of true eminence.

All great artists are truly original, and he who is original in his work cannot fail to become great and famous if he perseveres. Such men as Gibson, Helleau, Davenport, McCutcheon, Opper, Abbey, and many others are original in their work, and in their originality lies their greatness. They are not afraid to step out into the darkness, to originate and develop their own ideas, to stamp their own individuality into every piece of work they do.

If your instructor is not prescribing work for you which will develop and bring out your own ideas, your originality in this line, he is not doing his duty by you, and you should see that he does, or else obtain instruction from some other source.

Of the schools teaching all branches of drawing and illustrating, and which make a specialty of training the young artist to do original work, the Acme School of Drawing is perhaps the best. It is one of their requirements, and justly so, that a student shall be trained and his ability developed in this line.

Strive then to make original drawings. Do not be content to be a mere copyist, but put something of your own into all your work. You remember the artist's secret, as told by Olive Schreiner in Dreams. He took his own life's blood to make his colorings, he put his heart and soul into his work, and he had a style, individuality, and originality of his own. You can be as great as he, or anyone, if you will be original.

HOME STUDY.

Elementary Mechanics.

BY N. C. HURST.

PART II.

LET us now consider Pulleys or Blocks which are in every day use in hoisting weights, elevators, and moving heavy weights. Let (w) be the weight lifted or the resistance and (p) the force applied or the full and (P) the force necessary to sustain the stationary pulley blocks or in other words to resist the combined action of (w) and (p).

Fig. 4 represents the single stationary block, i. e., a single stationary pulley which can be used for obtaining advantage of position of pulling power only. (a) is the pulley or sheave of radius (r) and rotates about the axle or axis (o) and (w),(P), and (p) are the forces acting. To find the relation between (w) and (p) consider the pulley as a revolving lever, revolving about (o) as a center or fulcrum, then we have pr=wr (pr being the same as p×r) and since the (rs) are equal (p=w) or $\Sigma m=0$ since pr—wr=o. To find the value of (P) we take the algebraic sum of the vertical forces or parallel forces for all vertical forces are parallel practically considered. Doing this we have (P=W+p) and converting this equation into the form Σ vert. forces=o we have (P—W—p=o) or (P) equals the sum of (W) and (p). Fig. 5 is a special case of Fig. 4 where the pulleys are different in size or radius but are fastened together on the same axis and revolve together and are really two drums in that the ropes are separate and must wind about their separate pulleys or drums. Ap-

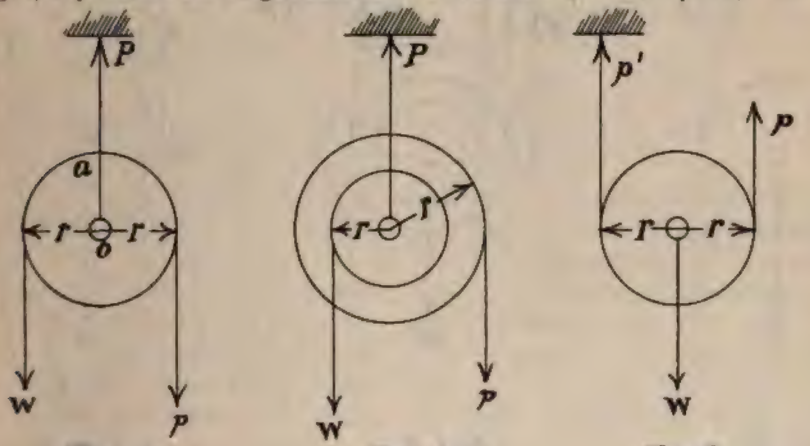


Fig. 4. *Fig. 5.* *Fig 6.*

larger than the pulley (C). Half this difference carries up the movable block and this lifts the load. Thus the less the difference between the size of pulleys (B and C) the greater load can be lifted with a given force exerted on the fly (H K) which is used in lifting. The analysis of this block is as follows: (Σ vert. forces) for the lower block gives $p'+p''=w$ or $p'+p''-w=o$ ($p'+p''$ being equal to each other as in the case of Fig. (5). For the upper pulley we have $P-p-p'-p''-w=o$ (w) being the weight of chain in (L K) $p-p'+p''$ are all equal to each other as in previous cases. Considering the movements about (A) of the upper pulleys we have $p\ r+p'\ r'-p''\ r-w\ r'=o$ or $\Sigma m=o$. Now let (l') be the distance moved by the fly (C E) and (l) be the distance moved by the fly (B D). Since the two pulleys are on a common axle and move together l and l' are proportional to the radii of their respective pulleys.

Since (l') moves downward and (l) upward $l-l'$ is the real upward movement of the chain and the force p''. The pulley (F) is a single movable pulley and we have already found that for such a pulley the force p'' moves twice as fast or as far as the load or resistance (w) therefore $\frac{l-l'}{2}$ is the distance moved by the resistance (w) corresponding to (l) and (l'). Now since p and p'' travel over the same pulley they must travel the same distance or (p) travels the distance (l). Applying now Σ work=o we have $pl=W\frac{l-l'}{2}=o$ or $p\ r=w\frac{(r-r')}{2}$ since (l) and (l') are proportional to (r) and (r') the differential pulley may be converted into a differentia windlass by substituting drums fo the fixed pulleys. This arrangement i seldom used, however, because of th length of rope required. The differential block is widely used for shor and heavy lifts and is very convenien to handle.

The Inclined Plane or grade is illustrated in Fig. (10). It is widel used to elevate loads a short distanc and in railroad work to get trains ove elevations. The relations betwee (P) and (w) for the arrangement i full lines is $P=w\frac{BC}{AB}$. This expression is derived from the expressio Σ work=o $P\ \overline{\times ab}-W\times\overline{BC}=o$ sinc force (P) in moving (w) from A t

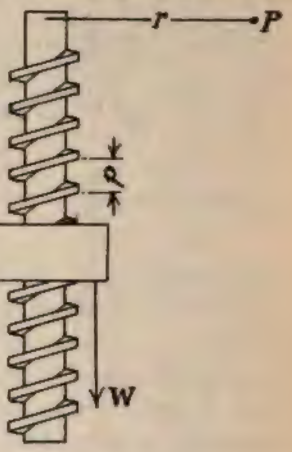


Fig. 11.

B moves through an equal distance, the work it does is $\overline{P\times ab}$ and since (P) in moving this distance elevates (w) a distance equal (b c) the work done on (w) is $w\times\overline{BC}$. For the same reason the expression $P=w\frac{BC}{CA}$ ap- dotted lines. The wedge is a movable

ples is the arrangement shown by the inclined plane and is often considered as a double inclined plane as in Fig. 10 (6). The equations are the same as those used for the inclined plane. The revolving cam is a special form of inclined plane as used in the stamp mill and various other machines.

The Screw is an inclined plane wrapped around a cylinder so that the height of the plane is parallel to the axis of the cylinder. If the screw is formed on the inside surface of a hollow cylinder it is called a nut. When the screw is used to overcome a re-

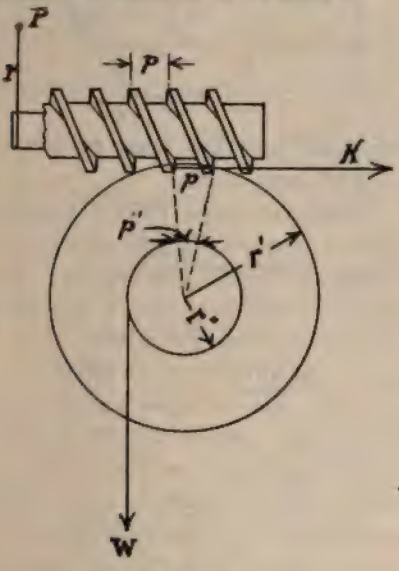


Fig. 12.

sistance either the screw or the nut may be fixed and the other movable. The acting force is generally applied at the end of a lever or wrench or rim of a wheel. Fig. 11 represents a screw and nut operated by a lever of length or radius (r), (p) is the pitch of the screw or height of the inclined plane for one revolution of the screw. (w) is the resistance at the nut and (P) is the force applied at the end of the lever (r). Remembering that while the resistance (w) is raised the distance (p) the force (P) revolves around a complete circle and moves a distance $2 \pi r$. Let us now apply the condition Σ work=o and we have $P2 \pi r - wp = o$ or $w = \frac{P2 \pi r}{p}$ [6.

The worm gear Fig. (12) is a special case of the screw and nut where the nut is replaced by a toothed wheel called a worm wheel: The teeth work in with the thread of the screw or worm and thus as the worm revolves the worm wheel revolves about its axis. (P) is the force acting on the worm at a radius (r) (r') is the pitch radius of the teeth in the worm wheel and (r'') is the radius of the drum on which (w) acts. Let (K) (corresponding to w in equ'(6) be the force at the pitch circle and worm threads due to the force (P) then $k = \frac{P2 \pi r}{p}$ [7]

Now apply $\Sigma m = o$ to the worm wheel and we have $Kr' = Wr''$ or $K = wr''$ (8). Substituting the value of (K) in equ (7) in equ (8) we have $P2\pi r = Wr''$ or $P2 \pi r = Wr'' p$ [9]

Now it is evident that the distance (p') moved by W while K moves through the distance (p) is to (p) as r'' is to r' or p' : p :: r'' : r' or $p' = \frac{pr''}{r'}$ (10). Substituting this value of $\frac{p r''}{r'}$ in equ. (9) we have $P 2 \pi r =$ W p' or the condition Σ work=o, since $2 \pi r$ is the distance moved by (P) while W moves the distance p'.

In all the above mechanical movements the part played by friction has

(This article continued on page 84)

Elementary Course in Mechanical Drawing.

(Continued from January number.)

INTERSECTIONS.

IN practical work, it is necessary to represent all kinds of regular and irregular bodies, which intersect or penetrate each other.

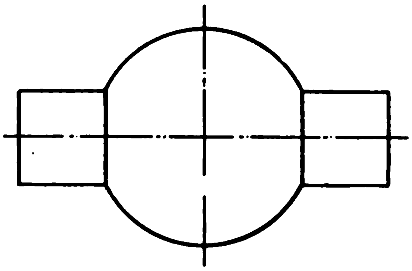
The knowledge required to do this is best obtained by study of the geometric solids, such as the sphere, cylinder, cone, pyramid and prism.

Simple intersections are produced when a body small enough to pass through another, enters one surface and goes out of another.

If the large object is bounded by plane surfaces, the intersections are simply sections of the smaller body, made by the plane surface of the larger.

Simple intersections are given by a cone or cylinder which penetrates a sphere in such a way that its axis passes through the center of the sphere. In this case, the plane of the intersection will be at right angles to the axis of the penetrating body, and the lines in which the cylinder or cone enters and leaves the sphere will be circles.

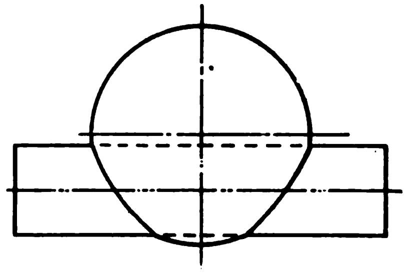
If the axis of the cone or cylinder does not pass through the center of the sphere, the intersections will not



be circles and must be obtained as explained later.

When bodies bounded by plane surfaces intersect, the lines of intersection will be straight and must connect the points in which the edges of each solid penetrate the other solid.

When curved bodies intersect or are intersected, there are *elements* instead of edges, which penetrate the



surfaces and they must be treated as if they were edges.

Then problems in intersections as they are generally solved may be reduced to simply finding the intersections of the elements of the surfaces and connecting the points.

PLATE XII. — Problem 1.

An 1½ in. square prism 3½ in. long has two intersecting prisms which are each 1 in. square and set as shown. Left prism is at an angle of 45°, up ½ in. from the base of the center one. Each is 1 in. long, horizontally from the edge of the vertical prism.

Center lines of Figs. 1 & 4 are 2½ in. from left border line, the base of Fig. 1 being 6½ in. from top border and the center of its top view is 1¾ in. from the top border line also. Right prism at center of vertical one.

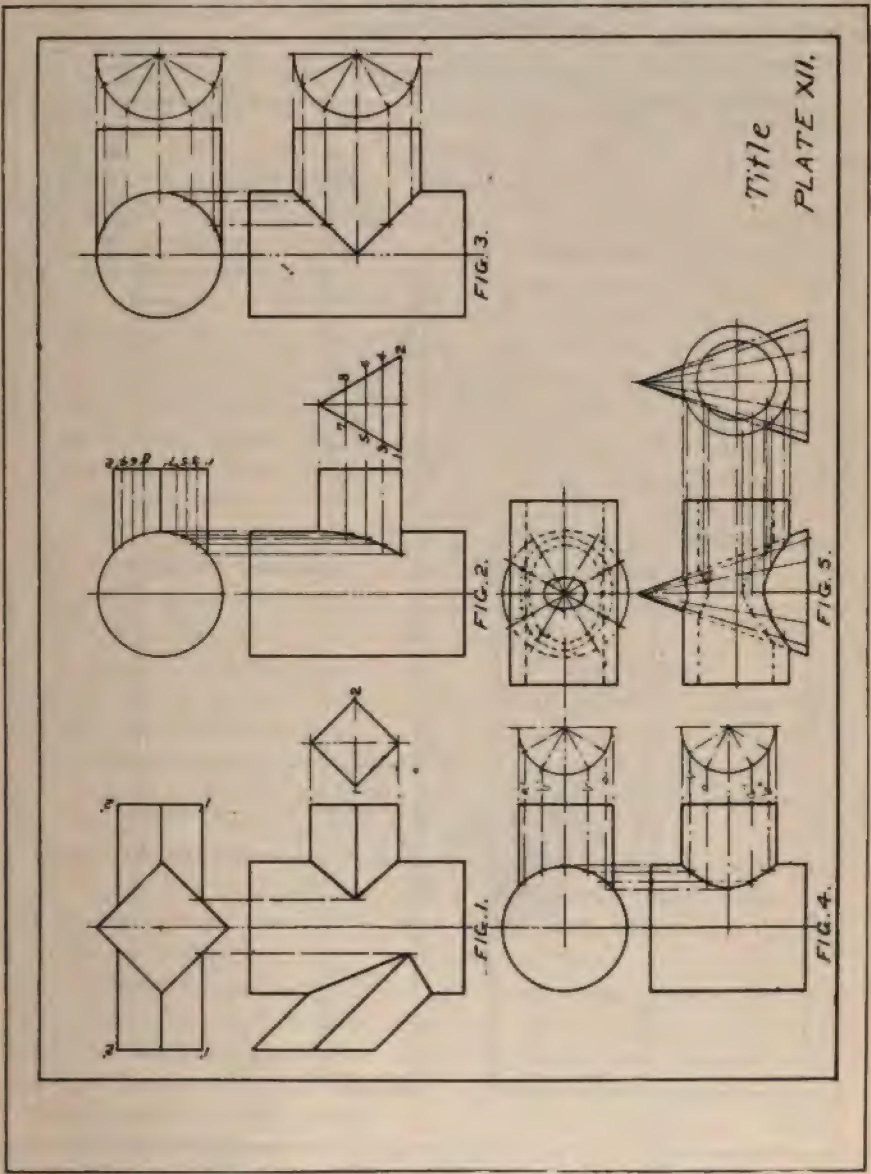
About 3 in. from the center of Fig. 1, draw the square and lay off 1 ft—2 ft. in the top view equal to 1—2 on the

square. Find the lines showing the intersecting surfaces by projecting down from the top view, where the edges of the side prism intersect the sides of the center prism.

PROBLEM 2.

which is 1 in., the latter being set up 1 in. from the base of the cylinder.

Center line of Fig. 2 is $5\frac{1}{2}$ in. from that of Fig. 1 and the triangle is drawn at the same distance from Fig. 2 as the square is from Fig. 1. Then



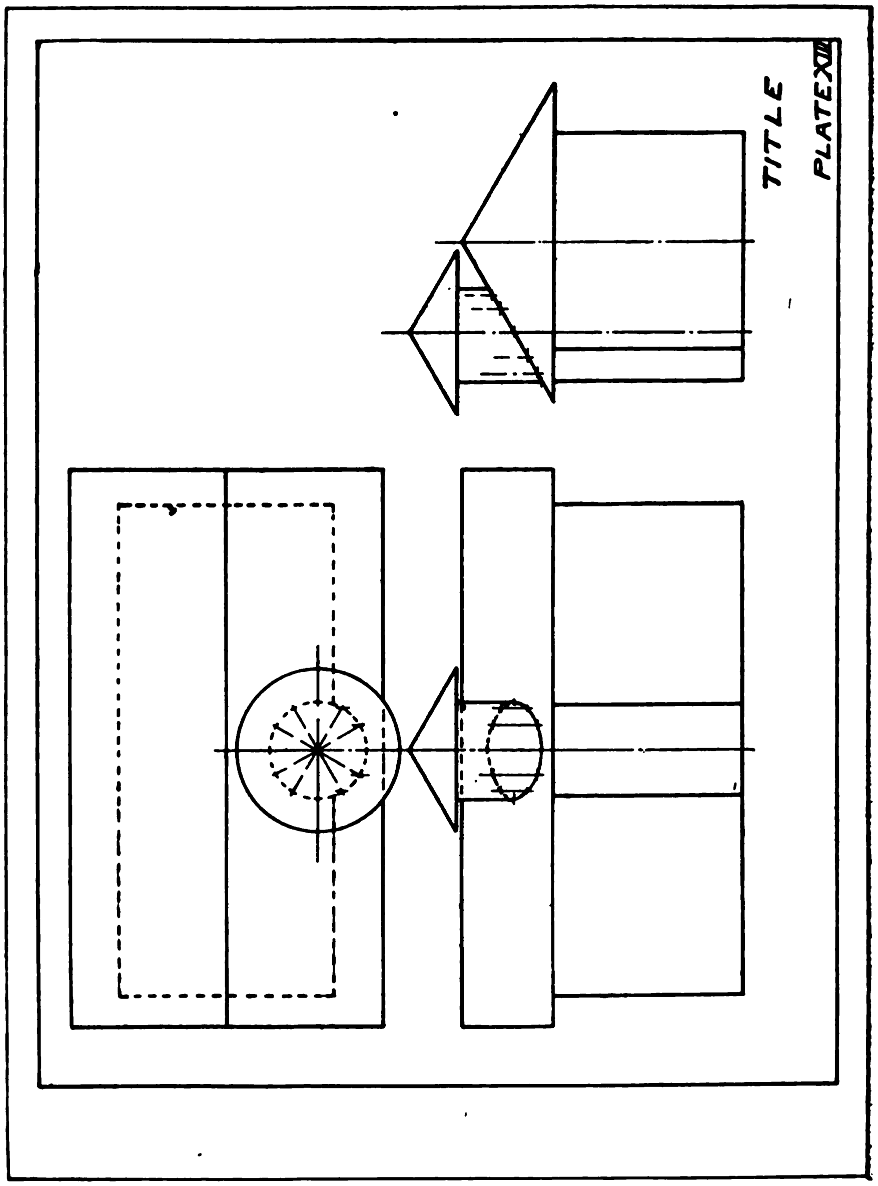
A 2 in.x$3\frac{1}{2}$ in. cylinder is intersected by a triangular prism, each side of

1 ft.—2 ft. in the top view is the same as 1—2 in the end view of the triang-

ular prism.

Draw in section lines 3ft.—4ft.= 3—4; 5ft.—6ft.=5—6, etc., locating 3, 5, 7, any place on the triangle.

The lines 3—4, 5—6, etc., are projected from the triangle to the side view and 3ft.—4ft., 5ft.—6ft., etc., are drawn in to cut the circle in the top view. The intersection of these lines with the circle are projected down to the front view and cross the lines from 3—4, 5—6, etc., giving points in the curve which is the intersection of the surfaces.



house roof until it intersects the center of the tower.

Center of house and tower 5½ in. from left border line of sheet. Center of house in top view to be 3 in.from top border line. Center of house in side view to be 3¼ in. from right border line and 1½ in. between center of town and center of house. Let the roof project ½ in. on each end of the house and the roof of the tower to be ¾ in. high measured in its center line down from the point.

Divide the circle of the tower in the top view into an even number of parts front view.

as shown and lay out elements in the front view by projecting down from the top; also the elements in the end view are as in the front view.

The intersection of these elements in the end view with the roof are to be projected horizontally to the front view, where they will cross the lines projected from the top view.

Draw in the line through these points with a French curve.

The dotted outline of the house body will indicate where the circle of the tower intersects the side of the house and this can be projected to the

(To be continued.)

Undiscovered Merit.

"I have been some time in this world, and the result of my experience is that there is one way by which success may be obtained with ability. In all my life I have never known an instance of undiscovered merit. There are too many seekers to allow ability to remain hid. If you possess ability and were placed in a diving bell and lowered to the bottom of the sea, expeditions would be fitted out to discover you and bring you back.

"No matter what calling you embrace, if you have ability you will be in demand. If a lawyer, think how many persons there are in trouble who would be seeking your advice. If a physician, how many there are who are ill who would want your services. If an architect, how many who desire better houses built. I have heard it said that a young man needs a pull to get a start. Pay no attention to that. If you have ability you will win."—The Hon. W. Bourke Cockran, in an address to the graduates of Manhattan College.

(Continued from page 79)

been left out since we were considering only the fundamentals. In actual practice friction plays quite an important part especially with the screw, worm gear and wedge where the work absorbed by friction often amounts to several times the useful work done, thus the applied force in practice is greater than the theoretical by an amount equal to the work absorbed by friction.

CURRENT TOPICS.

A Draft.

TO draw or not to draw,
that is the question;
Whether 'tis better in the
pride to suffer
The sting of fault in some
blue penciled tracing
Or to take heart 'gainst these accusing
tokens,
And by erasing end them. So to rub,
To ink, and by redrawing say we end
The error of some misfit iron-work,
That makes the shop to swear and
loudly wish
The drafting room were being slowly
warmed
In a forced draft.

'Twere better so to draw
(Weighing with care the length of
every line)
That when the fiend attempts to pierce
thy soul
With his blue pencil, he shall find thee
armed
In the security of right dimensions.
Thus if you may; if not, draw anyway;
For if you draw no lines, you draw
no pay.

P. H. W.

The next division of Elementary Drawing in the Home Study Department will be The Development of Surfaces, or "Pattern Drafting."

Some Drafting Room Practice is a new division of our magazine in the March number.

?

Why not keep a card index of information for your subscribers, as to what kind of treatment can be expected from any certain firm a man may be going to work for? Hasn't an employee as much right to be particular as to who he works for as an employer is about who he hires? There are some people who could not get you to work for them at any price.

Haven't shops been "bitten" so often by correspondence students that you destroy a chance of being hired by saying you are a Scranton man? In the language of a chief in a structural shop near Cleveland: those Scranton solicitors have flooded the market with silk purses made out of sow's ears. Draftsmen of the kind wanted are as scarce as ever, according to a "choicy" chief who gets to pay what he pleases for men?

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The Money Value of a Technical Education.

THE presidential address on "The Money Value of Technical Training," delivered before the American Society of Mechanical Engineers this week, will be likely to arouse considerable discussion, in private, if not in public. It is somewhat unusual to publicly weigh the advantages of education in dollars and cents, although it is common enough to do so in considering the practical questions of how long a boy shall continue in school and what course of study he shall pursue.

No one will dispute that Mr. Dodge's statistics are probably fairly accurate as a gauge of the relative earning power at the present time of typical young men trained in different ways; but it may well be objected that these figures tell only a part of the story, and that they are likely to be misinterpreted by the public.

On the face of the returns, the average man will have a salary of $41 at the age of 30 if educated in a technical school, as compared with $24 a week if he has only a trade school education, or about $16 per week if apprenticed to the machinist trade. Naturally, therefore, the ambitions parent decides that a technical education is the thing to give his son; and naturally, also, the multitude of engineering schools in this country, small and great, are overcrowded with students.

It must be remembered that there is another side to this picture. The four classes of men whom Mr. Dodge represents in his diagram are doing different classes of work, and it is because of this that such a difference exists in their rate of wages. If the graduate of an engineering college cannot find professional or executive work to do he may have to take a foreman's place along with the men from the trade school, or he may have to join the union and work at the lathe alongside the man who learned his trade as an apprentice in which case the chances are that he will find more difficulty in securing and keeping a job than the man who has been used to the work from boyhood; or again he may have to step a peg lower and compete with the unskilled laborer.

Accepting this as a fair statement of the case, it follows that whether a technical education pays in any individual case will depend upon the relation between the supply of and the demand for the men of such training. It is undeniably the case that in any industrial establishment there are ten or a hundred places for those who work with their hands to every one place for those who direct the work. Industry is carried on to make profits, not to furnish employment; and if there is a surplus of engineers they will have no better chances for employment than a surplus of laborers, in fact not so good, for they cannot so readily turn to some other occupation.

The lesson to be drawn from Mr. Dodge's statistics, therefore, is not that it pays to give a boy a technical education. It may pay or it may not. What Mr. Dodge shows is that for the boys who get and keep their positions it does pay, and from the point of

view of the general welfare of industry it undoubtedly pays.

It may be said, indeed, that from the point of view of the industrial welfare of the nation the more boys trained in technical schools the better, for there will then result competition between them and a "survival of the fittest," whereby the best and ablest will be "naturally selected" for the available positions. This is actually going on all the time, and within reasonable limits no one can object to it. Beyond those limits, however, it involves an amount of suffering, disappointment and loss that can hardly be contemplated with equanimity.

If there are next year, let us say, a thousand places to be filled with graduates from mechanical engineering courses and three thousand men are being educated to fill those places, it follows not only that two thousand will have to suffer disappointment, but that the thousand who do secure positions will be paid lower wages because of the fact that so many are applying for the positions.

It is for this reason that we always feel whenever the profits of technical training are publicly advertised, like uttering a warning to the youths who may thus be induced to enter the engineering profession. As they look at Mr. Dodge's diagram they will do well to reflect that the average graduate of a technical school who at 30 years of age is earning his $41 a week is earning it by just as hard work as the machinist who at the same age gets $15.30 in his weekly pay envelope. The graduate, to reach the position he holds, has had to devote six years of his life to hard study, during which time he earned practically nothing, and was under heavy expense. He made this investment, moreover, with the risk that it would turn out unremunerative. Perhaps he may prove unfitted for an engineer's life, perhaps in the struggle of competition another man will come out ahead, and leave him to take a subordinate place, or to remain unemployed. If he does succeed in securing his $41 a week position, it carries with it heavy responsibilities and risks. Taking all these things into consideration, the added earnings of the engineer over the laborer represent no more than a reasonable compensation for his expenditure of time and money.

We have taken pains to set forth these facts, not in dissent from or in criticism of Mr. Dodge's interesting address, but in order that it may not be misinterpreted. We would say no word to discourage from an engineering career the boy who is fitted for it by natural ability, and who starts with a clear appreciation of the difficulties and risks before him. Nor would we say one word to dissuade from pursuing a course in an engineering school any young man whose financial circumstances are such that he can well afford the necessary time and money, and who seeks the training as an education and not merely as a means of aiding him to earn a living. It is to a third class that words of warning need to be sounded—the youths who are making sacrifices for an engineering education with no particular fitness to make use of it in after life, and who will set no greater value upon it than can be measured in terms of dollars and cents. It is when it is expended on such men that technical training does not pay.—"*Eng. News*"

Ellipse or Circle Compasses.

THIS invention relates to improvements in ellipse and circle compasses, the object of my invention being to provide compasses for drawing ellipses, either with pencil or with pen, which shall be cheap and simple in construction and convenient of operation, compasses, moreover, which can be adapted, when desired, for drawing circles.

In the accompanying drawings, Figure 1 is a front elevation of my improved compasses. Fig. 2 is a side view thereof. Fig. 3 is a side view of the inking-pen detached, the wall thereof being broken to show a spring in the interior. Fig. 4 is a plan view of the compasses. Fig. 5 is a perspective view of the spreader detached.

Referring to the drawings, 1 represents a central tubular stem upon which is clamped, by means of a set-screw, 2, a collar, 3, having depending tugs, 4, upon which are pivoted, as shown at 5, the legs, 6, said legs being also clamped at any desired angle to said tugs by means of set-screws, 7.

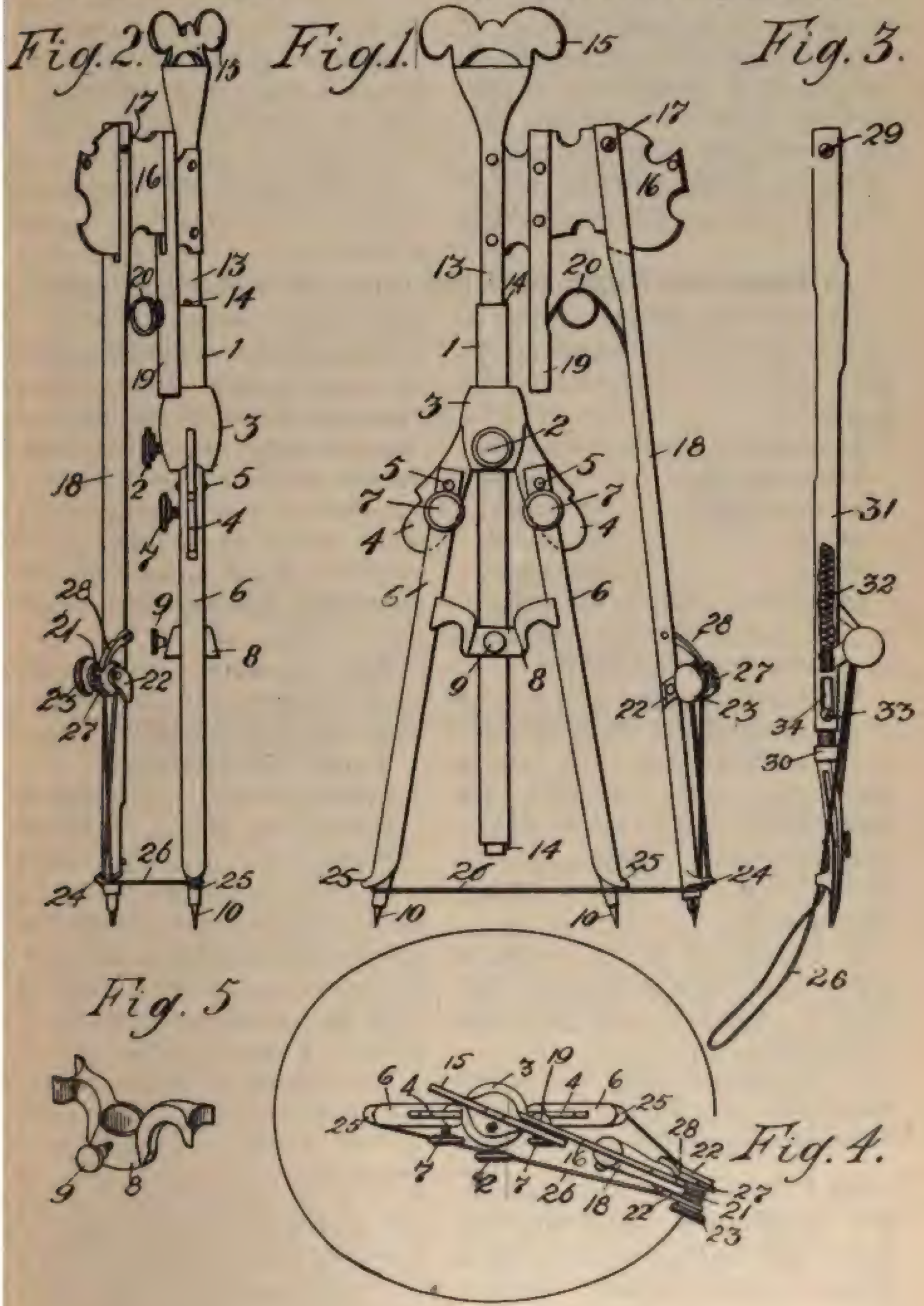
Eight represents a spreader, which is set by means of a set-screw, 9, at any desired point on the tubular stem below the collar and serves to spread the legs apart to an equal distance on each side of the stem. In the ends of said legs are carried pin-points, 10, which determine the foci of the ellipse to be described. By properly adjusting said collar and spreader the focal distance can be made of any desired length.

Revolable within the tubular stem is a rod, 13, having pins, 14, at the ends of the stem preventing its longitudinal movement in the stem. Said rod is provided at the top with a suitable handle, 15, and to said rod is clamped a plate, 16, having pivotally secured thereto, as shown at 17, a pencil-carrier, 18. To said plate is also secured a depending bar, 19, which forms a support for a spring, 20, the other end of which presses against the inner surface of the pencil-carrier, which is hollowed out for this purpose, said spring thus pressing said pencil-carrier outward.

Twenty-six represents a cord of inextensible material, as catgut or wire, preferably the former, which is doubled and wound around a small winding-pin, 21, carried in bearings, 22, upon the pencil-carrier and wound by means of the head, 23. The loop of said cord is passed through an eye, 24, carried at the lower end of the pencil-carrier, and is then passed around the ends of the legs, 6, immediately above the pin-points, 10, said ends being provided with shoulders, 25, at substantially the same level as the eye, 24, which prevent the cord slipping upward on the legs. The winding-pin also carries the ratchet-wheel, 27, engaged by a pawl, 28, upon the pencil-carrier, preventing the loop of catgut being drawn out beyond a predetermined length. This length will be the sum of the focal distances of any point on the ellipse, and since the length of the loop remains constant, and the focal distance of the ellipse, determined by the distance between the pin-points, is also constant, the remainder of the loop will be a constant quantity, and, therefore, by

the well-known property of the ellipse the pencil will, as it rotates about the foci, describe an ellipse.

The spring, 20, keeps the loop or cord always taut, as it constantly presses outward the pencil-carrier.



In Fig. 3 is illustrated the drawing-pen, which is used for inking the ellipse. Like the pencil-carrier, it is provided with a pivot-hole, 29, by which it is pivoted to the plate, and the end, 30, of the inking-pen is movable relatively to the main body or stem, 31, thereof, the latter carrying a spring, 32, which normally presses down the point of the pen, the lower section having a stud, 33, sliding in a slot of the main body.

If desired to use the device as a circle compass, all that is necessary is to slip the cord over the end of one of the legs, when the pencil-carrier will describe a circle about the other leg as a center.

The inventor is Mr. John W. Griffith, San Francisco, Cal.

A Blueprint Paper for Blue Lines on a White Paper.

The following process, credited to Captain Abney, yields a photographic paper giving blue lines on a white ground:

Common salt	3 ounces.
Ferric chloride......	8 ounces.
Tartaric acid........	3¼ ounces.
Acacia	25 ounces.
Water	100 ounces.

Dissolve the acacia in half the water, and dissolve the other ingredients in the other half; then mix.

The liquid is applied with a brush to strongly-sized and well-rolled paper in a subdued light. The coating should be as even as possible. The paper should be dried rapidly to prevent the solution sinking into its pores. When dry, the paper is ready for exposure.

In sunlight, one or two minutes is generally sufficient to give an image while in a dull light much as an hour is necessary.

To develop the print, it is floated immediately after leaving the printing frame upon a saturated solution of potassium ferrocyanide. None of the developing solution should be allowed to reach the back. The development is usually complete in less than a minute. The paper may be lifted off the solution when the face is wetted, the development proceeding with that which adheres to the print. A blue coloration of the background shows insufficient exposure, and pale-blue over-exposure.

When the development is complete, the print is floated on clean water, and after two or three minutes is placed in a bath, made as follows:

Sulphuric acid......	3 ounces.
Hydrochloric acid...	8 ounces.
Water	100 ounces.

In about ten minutes the acid will have removed all iron salts not turned into the blue compound. It is next thoroughly washed and dried. Blue spots may be removed by a 4 per cent. solution of caustic potash.

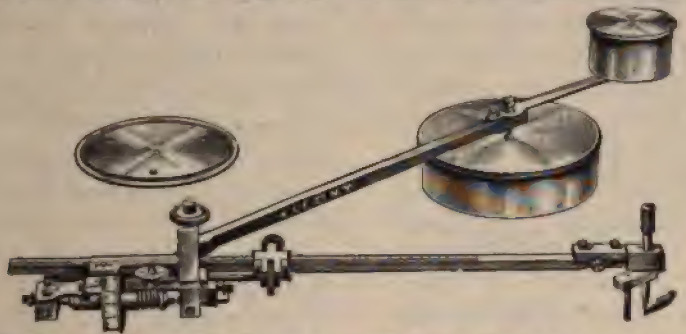
The back of the tracing must be placed in contact with the sensitive surface.—*Drug. Circ. and Chem. Gaz.*

Mr. L. D. Burlingame, chief draftsman of Brown & Sharp Mfg. Co., says: "The drafting office has three distinct functions to fulfill. First, it must be an interpreter *to* the shop; second, an interpreter *of* the shop; and third, a record *for* the shop." This is exactly true and every chief draftsman should see that his department of the work is fulfilling its function.

A New Book on Planimeters.

That the Polar planimeter and other instruments of its class have not received the attention or come into the general use by engineers to which their invaluable characteristics entitle them can be due only to a lack of knowledge of those characteristics and of the invaluable aid which these instruments are capable of rendering in almost every form of engineering calculations.

Were these operations limited to measuring the area of a plane figure and determining the average mean height of an indicator diagram, with which operations these instruments have heretofore been most commonly associated, the accuracy and rapidity



with which they perform these operations would alone make them of the greatest value to the Engineer, but when to these is added the ability to mechanically and with almost incredible accuracy solve almost any problem occurring in the Engineer's practice and with a saving of time and labor impossible by any other means, the Polar Planimeter becomes at once *the* indispensable instrument of the Engineer's equipment.

That the aid which the Polar Planimeter is capable of rendering in almost any branch of Engineering and Scientific work has not been more fully recognized has been due to the fact that up to the present time the principles underlying the theory and use of the instrument and their application to the processes of applied mathematics have neither been adequately studied nor given the position in Engineering literature to which their importance entitles them.

These considerations have led to the publishing of *The Polar Planimeter and its use in Engineering Calculations.*

The Author of this work is Mr. J. Y. Wheatley, C. E., the American authority on these instruments. This book contains not only a clear and concise description of the Polar Planimeter and the theoretical principles involved in its construction and operation, but also explains in detail the application of the instrument to the solution of nearly all of the most commonly occurring operations of engineering practice. It includes also very complete Tables of Factors and other data for the immediate adjustment of the Planimeter for these operations, thus making the book not only a treatise on the instrument, but also an office book for constant use,

Large Octavo, Cloth, with 12 Plates, New York, 1903, $3.00. Published by Keuffel & Esser Company, 127 Fulton St., New York.

Crokett's Trigonometry.

A rigorous, compact yet simple text coming from Rensselaer Polytechnic Institute. While the book is peculiarly adapted for use in technical institutions, it finds a proper place wherever facility in the use of the tables is required. Special care has been taken to have the tables absolutely correct, in the last decimal place. The arrangement of the computations, for the convenience of students, has also been made as nearly perfect as possible. The book can be used by beginners, but it is intended to furnish a thorough course.

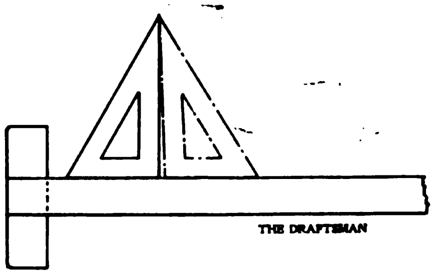
Published in four forms:

Elements of Plane and Spherical Trigonometry With Tables.................$1.25
The same, Without Tables..... 1.00
Logarithmic and Trigonometric Tables Separate 1.00
Elements of Plane Trigonometry With Tables 1.00

The American Book Co., 317 Walnut St., Cincinnati, O., publishers.

To True up a Triangle.

Triangles are seldom tine when first received from the factory, often



a long 30-60° one will show two lines when one is drawn as in position, and when the points are placed on the vertical line, but in the reversed position.

If the two positions do not fit the same line, the angle at the base is not 90° and can only be made as by filing off along the base.

Triangles have been known to wear off more at the heel than at the points and most of them would set as shown in the two positions than otherwise.

A straight flat smooth file is the best to use in working the triangle into shape.

The United States is now the greatest coal-producing country in the world, the output of 1903 reaching 300,000,000 tons. This is four tons of coal for every man, woman and child in the United States.

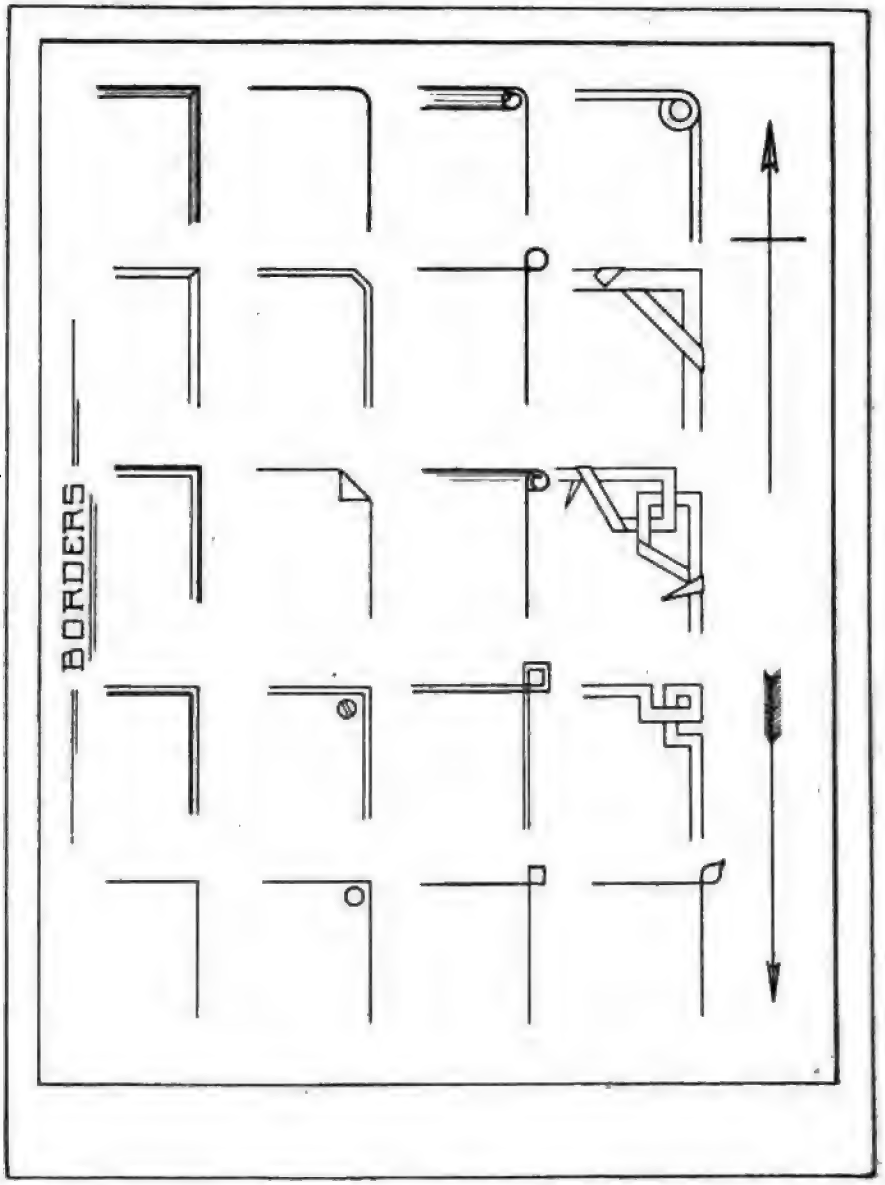
With 385 pounds of smokeless powder the new forty-calibre, twelve-inch gun will send an 850-pound armor-piercing shell through nineteen and five-tenths inches of Harveyized nickel-steel armor at a distance of a mile and a half.

A tree using aluminum almost to the exclusion of other mineral elements has been reported in New South Wales by H. G. Smith, of Sydney. It is known botanically as Orites excelsa, R. Br., and the aluminum is deposited as a basic succinate. Other flowering plants show only a trace of aluminum, although it seems to serve as a food of cryptograms.

It is not against the law to transact a legitimate business under an assumed name.

Central Institute

Fancy Borders.



Some fancy border line are hereshown that can be used for general drawings and title sheets.

Labor World.

Work on the Indianapolis (Ind.) Labor Temple is expected to begin January 1.

The Trades Assembly of Duluth, Minn., wants free evening schools established.

Broommakers of Milwaukee, Wis., have received a thirty-five or forty per cent. raise in wages.

The Canadian Parliament has passed an enactment that Asiatics shall not be employed on Canadian roads.

Sheep butchers throughout the country have accepted the wage increase of twenty-five cents a day that was offered by the packers.

Membership in the Journeymen Blacksmiths' national organization has increased an average of over 2,000 per month in the last year.

There are nine 'longshoremen's workers' unions in Queensland, Australia, and they all belong to the Waterside Workers' Federation.

Indianapolis (Ind.) labor unions will try to secure the choice of that city for the convention of the American Federation of Labor in 1904.

There is a movement on foot to increase the number of members of the Executive Council of the American Federation of Labor to eleven.

At Boston, Mass., a resolution to organize the pearl button workers was introduced at the convention of the American Federation of Labor.

New Orleans, La., 'longshoremen have made a three years' agreement for their work. This follows a prolonged and costly strike of 8,000 men.

Minnesota farmers at Kenyon built their own elevator seven years ago at a cost of $14,000. Their annual profits are more than the cost of the building.

A general reduction in the wages of engineers is demanded by the engineering employers in Belfast, Ireland, following upon the reduction in the shipyards.

The Pope Bicycle Daily Memomranda Calander.

The re-issue of the Pope bicycle daily-leaf calendar may be considered the opening gun proclaiming the natural and healthful return of bicycling. Col. Albert A. Pope, the founder of our bicycle industries and the pioneer of the Good Roads Movement, is again at the head of the bicycle industry. Upon the 366 calendar leaves are freshly written lines from the pens of our greatest college presidents, doctors, clergymen, statesmen and other eminent men and women, all of them enthusiastically supporting bicycling. Half of each leaf is blank for memoranda. This calendar is free at the Pope Manufacturing Company's stores, or any of our readers can obtain it by sending five 2-cent stamps to the Pope Manufacturing Co., Hartford, Conn., or 143 Sigel Street, Chicago, Ill.

A Progressive Patent Bureau.

Popular Mechanics, a publication which has come to the front in the past two years with leaps and bounds until it now has a circulation larger than any publication of its kind in the world, has inaugurated a patent bureau known as the Popular Mechanics' Patent Bureau, and from all evidences, it is as great success as the publication, which is undoubtedly well known to the readers of the "Draftsman." The Bureau is well organized, their attorneys and consulting experts are all practical men of large experience, and the bureau is, we understand, prepared to make research in the patent offices of this country and all foreign countries at a very moderate charge. Their charges for securing patents and prosecuting infringements and promoting the interest of their clients in every possible way, are very reasonable.

The bureau is rapidly extending its scope by having representatives in all the manufacturing districts of the United States and many subscribers of this publication who are conversant with patent work drafting would find it to their interest to represent this bureau in their locality, if no such agent has already been appointed, and we would advise communicating direct with the bureau whose main office is in Chicago.

The Patent Office of the United States was never more busy than at present. Under recent decisions of the Commissioner of Patents and the Courts, preference is given to the diligent inventor where there is any question as to who made the invention first. By diligent inventor is meant the one who first perfects his invention in practical form and applies for a patent.

Many inventors lose the fruits of their inventive ability through a disposition to procrastinate. This is truly a mechanical age, as realized by the progressive publishers of Popular Mechanics and inaugurators of Popular Mechanics' Patent Bureau, and the draftsmen of the country are certainly benefited by the great activity in mechanical lines.

"A Designer'sNightmare"

THE DRAFTSMAN

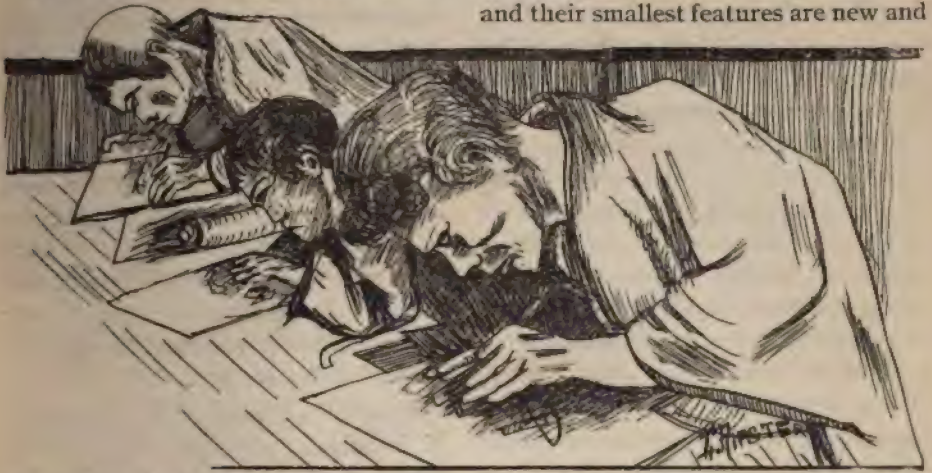
Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

The Japanese Workman at the Worlds Fair.

THE work of the native draftsman and other artisans employed on the side of the Japanese government buildings and grounds at the World's Fair is now well under way and is proving distinctly interesting to the general public.

It is natural that this should be the case, owing both to the unusual methods of these workmen, as judged from the American point of view. and to the high artistic values of the results attained. In many instances the tools used by the Japanese are operated in exact reversal of the American style—their saws, for example, being so made that the teeth cut into the wood only when the saw is drawn towards, not pnshed from the body, and their jack-planes working in similar manner—and this fact is in itself sufficiently out ot the ordinary to attract the widest attention. Then, too, the buildings, gardens and grottoes being constructed are Japanese to the minutest detail and their smallest features are new and novel to the average citizen of this country.



It is, therefore, a picturesque object lesson that is now being presented by the preparation for the Japanese government exhibit at the World's Fair. Japan proposes to prove to the world that she is abreast of the most modern

(Continued on page 140)

MECHANICAL.

Mechanical Misconceptions.

BY R. T. STROHM.

THE patent office records are full of descriptions and illustrations of devices whose sole claim to the protection of patents lies in the fact that they are original and unique applications of recognized principles, and not because they possess any real commercial value. They were conceived after much thought and study, if one may judge from the ingenious combinations brought forth. But after being patented they were forgotten. Apparently their action was faulty, or else they failed to do as well as other devices already widely used for similar purposes.

The energy represented by these abandoned conceptions of ingenious minds is enormous. The pity of it all is that it has been put forth with so little value returned. Yet in nine cases out of ten the whole cause of the failure is due to the fact that the inventor has misused or misinterpeted some well-known physical law. And further, if the inventor had but had a proper understanding of the laws which he must apply he would have foreseen the difficulties he must encounter and would have been saved the loss of time and labor.

Illustrations of errors of this nature are many and various. One man who was very much interested in the improvement of the steam engine, became very much concerned about the pressure upon the ordinary slide valve. He knew that it not only caused excessive friction and wore out both valve and seat very rapidly, but that the power expended in moving it was considerable, and that a reduction in pressure on the back of the valve would result in a decrease of wear, friction, and lost work. Actuated by the idea of improving the slide valve, he brought out the type shown in Fig. 1. Instead of the usual flat back he had made a pyramid. His idea was that the steam, in pressing down on the sloping sides, would slide off, as rain runs from roof of a house. Of course his reasoning was wrong in that he had not observed the fact that a fluid presses in all directions with the same intensity and not in a single direction, as would be the case if the same total pressure were applied vertically through the medium of a short pillar having its lower end resting upon the inclined valve surface.

Another instance of misconception of important physical laws may be cited. The writer was at one time called upon to pass judgment upon the utility and practicability of the device shown in Fig. 2. It represents the essential parts of a new form of steam engine consisting of two pistons, A and B, fitted to separate rods, one rod being carried through the opposite piston and rod to the outside of the cylinder,

where each rod is connected to its own crank. Between the piston at the center of the cylinder is the steam port C, the steam being admitted between the pistons, forcing them apart, and causing each to make a stroke approximately half the length of the cylinder. The inventor of this scheme contended that it would be a very economical arrangement. He argued that in all ordinary engines the pressure against the cylinder head is equal to that against the piston, and that as the head is stationary half the power was being wasted. By his arrangement one piston became practically a movable cylinder head, so that the pressure exerted on each would perform work. This, in his mind, appeared to offer opportunity for great gains in power.

The fallacy of this reasoning is quickly shown. Mere pressure is not work. A cubic foot of cast iron lying on the ground presses against the earth with a force of 450 pounds. This pressure acts constantly, but no work is done or lost. The mere fact that steam presses against the head of the cylinder does not indicate a power loss. To produce work, force must move through space, the product of the force in pounds and the distance moved in feet being the foot pounds of work accomplished. In the case of the ordinary engine, the force on the head of the cylinder does not move through an appreciable distance and the work done is nothing. Further than this, it is absolutely necessary that the steam shall act against either a stationary or a movable head. Action and reaction are equal and opposite in direction. To produce any pressure whatever upon the piston, there must be an equal and opposite reaction against the head, whether it be stationary or movable.

An indicator, attached to the cylinder, would quickly show the fallacy of increased work obtainable. A card taken from a single piston engine whose stroke is equal to that of the two pistons, and having the same volume of steam at cut off, would appear as in Fig. 3. A card from the double-piston engine, reproducing the travel of each piston, would appear as in Fig.2. Comparison of these cards shows that they have equal volumes and pressures at cut-off and equal volumes and pressures at the end of the stroke, and that the areas are equal, indicating that the same amount of work is done in each case.

The two illustrations given serve to bring out the point which has proven such a common stumbling block. That is, ignorance of physical laws, upon which the success of the device is dependent, and disregard of which must inevitably end in failure and disappointment.

In order that any device may prove a success, it must embody a number of essential points. In the first place it must be practical and not merely a well developed theory. It must accomplish its purpose, and it must do so at least as well as, and preferably better than, any other device for the same object, with which it must compete. Its cost must not be prohibitive, nor greater than that of other similar devices of equal utility and efficiency. It must attain the purpose as simply as possible, since the greater the number of parts and the more complicated their arrangement, the greater is the

liability to derangement and damage. Last of all, it must be durable. No owner of machinery likes to pay a high rate of interest on his investment for

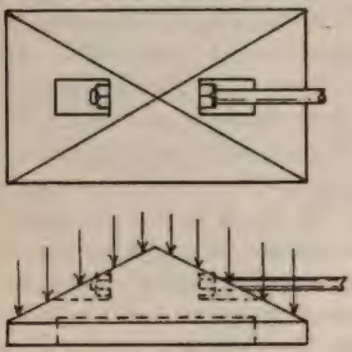


FIG.1.

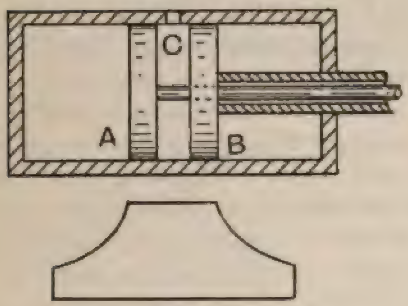


FIG.2.

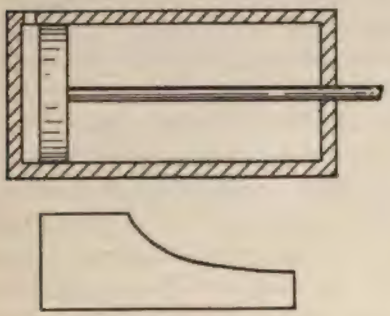


FIG.3.

the supply of repairs, and the durability of a machine is a potent factor in its commercial success.

A Draftsman is an Inventor.

Vincent Link, who came here from Bellevue, O., some time ago to be employed as draftsman at the Geneva Automobile & Mfg. Company's plant and who is in charge of a small force of workmen at that shop, completed an invention last spring or summer, which is now being successfully used at a plant in Radford, Va.

C. W. Pratt and R. P. Morgan of this place began operating a skewer factory there this fall, and they desired a better skewer pointer than the old one used at the local skewer shop a number of years ago. Mr. Link said that he could make a pointer, and they told him to go ahead with it. So at odd spells, and outside of the company's time, he completed an improved skewer pointer at the automobile shop. He completed a machine which would make 2,000 points a minute, or point on both ends 1,000 skewers in that time. The above gentlemen purchased it, paying him about a fair price for it, and they are now using it in their Virginia skewer plant. The machine was kept stored at the automobile factory a long time before Messrs. Pratt and Morgan called for it.

Mr. Link is quite a genius, and it is understood that the company have in the past used many of his suggestions in regard to improvements and different devices on their machines.—"*Press Times*," Geneva, O.

Engineers expect soon to be able to burn gas in such a continuous stream that it will be useful in the turbine form of engine.

Checknig a Drawing.

THE "checking" of a drawing is the equivalent of proof-reading in the newspaper office of the country.

It is the correcting and approving of the shapes shown and the figures given and should be done by some responsible person, one who understands the work in hand.

A drawing may be checked by simply adding up dimensions to see that they total the one given, and make observations to see that all parts will

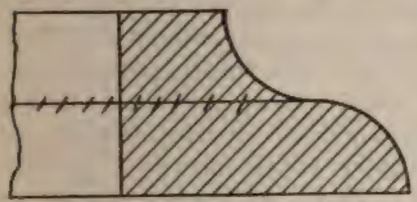


FIG. 1.

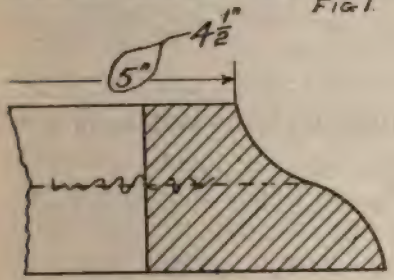


FIG. 2.

go together properly. Aside from this, no more is done by the "checker" in many cases, but in most drafting rooms, the checker goes into some points of the design, too.

When a line is shown solid, which should be dotted, the checker cuts his blue pencil (blue being used because it can be seen more easily) through the line as in Fig. 1 and if it should not appear at all, a wiggle is run through it as in Fig. 2.

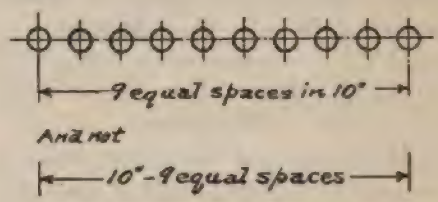
Dimensions that are to be changed are noted by surrounding the offending figures and carrying the mark to one side as in Fig. 2.

Since, in many drafting rooms, the tracing is checked and not the drawing, some care should be exercised in marking with the pencil, for in erasing it, later, the surface of the cloth is much disturbed and tracing so treated look very badly.

The spelling and arranging of the titles and notes are also looked at and such corrections made as are necessary.

The best plan is that the checker should first look over the drawing and make such alterations as he has authority and ability, then it is traced and checked more closely.

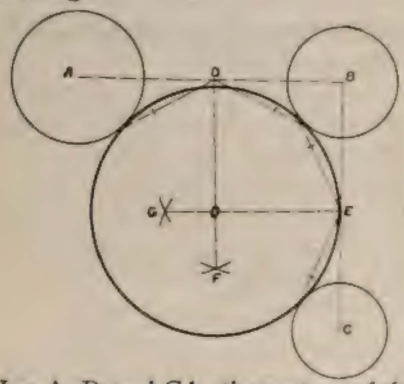
In the case of noting the numbers of spaces for rivet or bolt holes, it would be better to have it appear thus:



for by writing in the note, the number of spaces is more correctly given, though a hole or two more may be shown, the note is the thing to be followed, not the picture.

Editor The Draftsman:

I was interested in Mr. MacDonald's construction in your January number, i. e., to describe a circle tangent to three given circles whose diameters are different, and herewith submit the following:



Let A, B, and C be the centers of the three given circles whose diameters are different. Join the centers A and B, also B and C. Bisect any two of the distances between the circumferences, in the points D and E, and from these points draw lines tangent to each of the circles respectively. Bisect the angles thus formed at D and E by the lines D F and E G, intersecting at O. The point O is the center of the required circle. D. J. MacLean.

DIFFERENCE IN MACHINE SHOPS.

In Europe one shop often builds a number of different kinds of machines, while in America, as a rule, each factory is devoted to some special machine.

Coke Drawing Device

A machine for drawing coke ovens is in use at Continental No. 1 works of the H. C. Frick Coke Company, one mile from Uniontown. It has been inspected by operators from the entire coke region, and has proved a decided success.

Under the old method one man draws an oven of coke in about three and a quarter or three and a half hours, or an average of two and a half ovens a day. The new machine draws about two and a half ovens an hour, and only one man is required to operate it. By the machine the coke is drawn out of the ovens by a scraper and falls into a receiving conveyor, and is then taken along and dumped directly into the car for shipment. The machine was invented by J. A. Hebb, of Hopwood, this county, who worked on it for nine years.—Philadelphia Press.

Boiling Kettles without Coal

Every day in London scores of workmen's kettles are boiled in lime that will afterwards be used for its proper purpose. Just before the breakfast hour, say, one of the workmen empties a quantity of the dry lime from a sack. In the center of this lime he makes a hole, and into it water is poured. Then he puts his kettles into the water, and in a few minutes the kettles boil. In thousands of cases a fire is thus spared.

The fact that 75 per cent. of the central electric stations of the United States are in places of less than 5,000 inhabitants, as compared with 22.8 per cent. of the gas plants, indicates the wider distribution of the electric stations which have enabled the inhabitants of the small places to enjoy illuminating facilities confined heretofore to the larger cities and towns.

ELECTRICAL.

The Young Electrician in the Machine Shop.

BY GEORGE E. WALSH.

ELECTRICITY has become such a common factor in our industries that a practical and theoretical knowledge of it in the shop and drafting room are almost essential to success.

As a whole the subject is too comprehensive for one to study without particular reference to the different specializing tendencies. The modern electrical engineer devotes his attention either to telephone construction and operation, to electrical railway building and work, to electric lighting and heating, or to electrical shop equipment. Each of these several specialties are further divided and subdivided, and there are marine electrical engineers, architectural electrical engineers, subway electrical engineers, and submarine electrical engineers.

In the shop, however, electricity is chiefly a factor in the operation of machines. The engineer who installs the shop with its electrical equipment must be one who can study out the problems of economy of space and operation. The displacement of steam-driven machines by electrical-driven ones can be accomplished only by a perfect demonstration of the latter's superiority. There must be economy of time and output, and a saving of power. Usually the properly equipped electrical shop saves in many ways. With multispeed motors for driving tool machines there is a distinct saving in time, power, and output.

But space is always an important consideration in equipping a shop or factory with motive power. As a rule the electric equipment requires less space than steam. A good deal depends upon the planning and designing of the engineer who has the installation in charge. The young electrician in the shop never had better opportunities to show originality and skill in designing and planning. So much of the work is largely experimental today that manufacturers of tool machines are required to build many which can be easily adapted to steam or electricity for driving. A good many shops will not entirely abandon steam, but use it as an auxiliary power. This skepticism or conservatism indicates the attitude of many old shops toward electricity. They are willing to give it a trial, but they are not entirely satisfied that there will be no breakdown or unforseen trouble.

However that may be, the knowledge of practical electricity should be

a part of the education of every worker in the shop or drafting room, for the use of this agent for power purposes will steadily increase, and in time it will entirely displace steam. In a dozen different ways a practical knowledge of its working force will help one in his daily work. The young electrician who makes a study of shop equipment cannot do better than to specialize his knowledge. There is need for specialists who can rise above the average, and plan and design work which few electrical students know how to do. There are many shops so narrow and cramped that the placing of electrical machinery in them to occupy as little space as possible becomes a problem. There are corners in shops which owing to the position of some explosive substance it is impossible to introduce steam pipes, and the young electrician should be able to plan his work so that tool machines could occupy such corners without introducing the element of danger at all.

The operation of electrical-driven tool machines is a part of the daily routine work of most large shops today; but the skilled operator who understands his business will not rest content with simply running the machines. Any one with a little practice can do this. The mere turning on and off of the current is the work of boys, but the manipulation of the machines so the highest efficiency is obtained from them is quite another matter. The life of a tool depends upon its manipulation fully as much as upon its use and original composition and manufacture. Electrical-driven tool machines are after all delicate mechanism, and they need to be handled by experts. In a good many shops it is difficult to secure proper workmen to handle the new multi-speed motors, which work with wonderful results when operated by skilled mechanics. They have a high degree of efficiency, and for every instant that they are working they economize in power and results. There is no waste of power through idleness or ineffectiveness.

But such tools can easily be run out of order, and their repairing is not a simple feat. The repair bills of a modern shop too often present a formidable item. Shop economists today are studying this end of the work. Good machines to begin with will necessarily cut down the repair account; but fully as important in this respect is the skill or lack of skill of the operators. The tendency of modern industrial life in and out of the shop is to secure the highest skilled labor, and pay well for it. It is the man-power efficiency that is coming in for investigation and test. We have perfected our machines to such a point that we hear much of their highest efficiency, and now the shop is tending toward the elimination of the inefficient workmen, and raising the standard of those remaining behind.

In nothing is this better illustrated than in the demand for shop workers of all kinds who have a fair working knowledge of electricity. Is it possible to turn over an electrical-driven set of machines to an operator who is not familiar with the mechanical part of electricity? It is possible, but not practical. A man might study the

method of manipulation of levers and handles, and yet not understand the reason for the machine's steady operation. But in the event of some little trouble, some slight shifting of the load that causes a stoppage, some little breakdown or cutting off of the current through tangling or crossing of wires, would such an operator prove of much value? In small shops it is not always possible or practical to have an expert electrical engineer within calling distance at all hours of the day. With only a few electrical-driven machines on hand, such an expense would rob the shop of all profits from the new machines. Consequently the operators themselves must know how to manipulate the machines, and how to discover slight troubles that may develop, and also how to keep the machines and the wires and belts in proper smooth running order. In other words, the ordinary machine operator must be somewhat of an electrician. There is no line drawn as to how much of an expert, but the more proficient he makes himself in this line the more valuable he becomes to the shop.

The electrician who plans the installation of the new equipment finds that his labor is largely measured by the thoroughness of his education and skill in his specialty. The higher mathematics of electricity cannot be taught in text-books; it must come from practical study and experience. The inquiring mind in the shop is always open to new suggestions and discoveries. It is ready to find some new kink that may at the opportune moment prove of more real value to the shop than half his theoretical education. The open, receptive and studious mind is in a fair way then to become an inventive mind. Invention is not after all the result of sudden inspiration so much as it is unconscious reasoning out of some simple principle. From our shop workers there have come many of our best inventions. Thrown into daily contact with their machines they see better than outsiders where improvements can be made. A poorly working machine, or a clumsy mechanism that only half does its work, should be an offence in the eyes of an expert engineer or mechanic. There is something wrong in the principle or its adaptation.

In the electrical field there is a wider margin for invention and improvement than in almost any other. New methods of equipping the shop with machines and labor-saving implements must constantly raise the standard of the shop. In a good many instances a general invention could not accomplish the results desired. Peculiar conditions of adaptation prevail, and it is the skill, invention or common sense to do this that makes one electrician superior to another.

"We cannot lose such and such a man, no matter how many others we must lay off," is frequently the decision of shop superintendents. "He is invaluable because he knows every detail of the shop mechanics." In another shop, the conclusion is reached: "We expect a good deal of that man because he has already made valuable suggestions. Inventions? No, they can hardly be called inventions; you couldn't patent them; but they are worth more than inventions to us. They have systemized our shop, and

eliminated waste practices."

In times of industrial depression the valuable man is the last one to be laid off. His work has made him a necessity to the mill or shop. The practical electrician who can repair and improve the machines is a man of this sort. Another who can adapt the mill operation so that money is saved to the firm is a second invaluable attache. The simple grouping of machines to be driven by electricity so that the least amount of power is used for given results is a matter that is decided before the shop is equipped; but sometimes it is desirable to throw out of the group a number of machines. The shop is not running at full force. Depression in trade is causing mills to economize in production and to limit the output. The detachment of machines from the different groups so that the highest efficiency can be obtained from those kept running is a matter not easy to accomplish. Outside expert advice costs money and many shops are opposed to calling in outside professionals. At such times the man within the shop who has made himself an expert will meet his opportunity. He will rise to the occasion, and prove his worth. The wisdom of keeping just a little ahead of his profession, and not simply abreast of it, will be demonstrated.

The reconstruction of old shops is going on today as never before. It is not always possible or profitable to tear down the old and build up new. But the old plant must be brought up to date. The newest equipments must be installed. It is a costly undertaking sometimes to reconstruct a shop, and manufacturers hesitate some time before giving the order. Expert outside consulting engineers and electricians hold their services ready for such emergencies, but they come high, and the expenses at all times must be considered in shop reconstruction.

A good many of the old wooden shops were not built to accommodate modern electrical-driven machines. The roofs and side beams are not strong enough to withstand the vibration and extra load. Car repair shops of the leading railroads are nearly all of this character; but their interior equipment must be brought up to date, and it is being accomplished.

The question of gradually reconstructing the shop to suit modern conditions is one that requires the most study, and the shop superintendent or electrical engineer who can so plan this work that there will be little interruption of work is a man of much worth to the company. During dull seasons a part of the shop can be turned over to him, and when this is installed with new machinery he can turn to another portion. The problem of strengthening the roof and wooden sides in places where the heavier machines will be located must be considered. There are a number of railroad repair shops that have thus been revolutionized in the course of a few years so that they are the most efficient in the country today. They were transformed through the intelligent cooperation of the inside men, with scarcely few outside suggestions beyond those given by the machinery company's experts, whose services were freely at the purchasing shop's disposal. A shop that has inside

workers of this type is fortunate, and it is not likely that they will be dropped from the pay rolls except under extreme commercial depression.

Some Electrical Data.

I AM sending you some tabulated data on current capacities for various electric incandescent and arc lamps, which will be of value to readers of the "Draftsman" engaged in electrical drafting as well as to others desiring the information, without being compelled to consult various text-books or catalogues and running the risk of not finding exactly what is wanted.

M. H. ABREMOVICH.

Current in amperes for a 16 C.P. lamp

Watts per C. P.	2.5	3.0	3.5	4.0
220 Vots	....	....	.26	.29
110 "	.364	.436	.51	.58
100 "	.40	.48	.56	.64
50 "	.80	.96	1.12	1.28

Note:—For a 32 C. P. lamp, ampere capacity is doubled.

Current in Amperes for open Arc Lamps.

Nominal Candle Power	Constant current circuit 45-50 volts.	Constant potential circuit 45 volts.	Alternating current circuit 28 volts.
2000	9.6	10	16
1200	6.8	6.5	10
800	4.25	4.0	6.5

Current in Amperes for Enclosed Arc Lamps

Type	Circuit	Current in Amperes	Volts Across Arc.
D.C. Serries	Constant Cur't	6.6.	72 to 76
A.C. "	" "	6.6	70 to 74
D.C. Multiple	110 Volt	4.5 to 5.5	76 to 80
D.C. "	" "	2.5 to 3.0	76 to 80
D.C. "	220 "	2.5	150
A.C. "	110 "	6.0	70 to 73

Inventions of Peter Cooper Hewitt.

BY A. P. WILLS, '94.

THE *Hewitt Vapor Lamp.*—The starting point of all the recent inventions of Mr. Hewitt was the mercury vapor lamp, which was first introduced at a demonstration before the American Institute of Electrical Engineers at Columbia University, on April 12, 1901.

The mercury vapor lamp in certain forms was known many years before this. Chief among those who, previous to Mr. Hewitt, have employed mercury vapor carrying on electric current as a light giving device, was Dr. Arons of Berlin, whose important work in this direction was published in 1892. But neither Dr. Arons nor others before Mr. Hewitt succeeded in producing lamps of such design as to give promise of much success under such practical working conditions. It was left to Mr. Hewitt to make the important discovery of what the geometry of a mercury arc-lamp must be in order to furnish a self-regulating device, with commercial possibilities. He early recognized the important role which the density of the vapor plays in the operation of the lamp; and he also showed how the density of the vapor can be controlled.

Figure 1 shows one form of the Hewitt lamp. It consists of a vertical cylindrical tube swelling at the top,

In the process of manufacture the lamp is connected to the pump by means of a small tube not shown in the figure. The pumping out process forming the "condensing chamber" which contains the anode, A, (usually of iron): the cathode, B, is usually simply a puddle of mercury at the bottom of the tube.

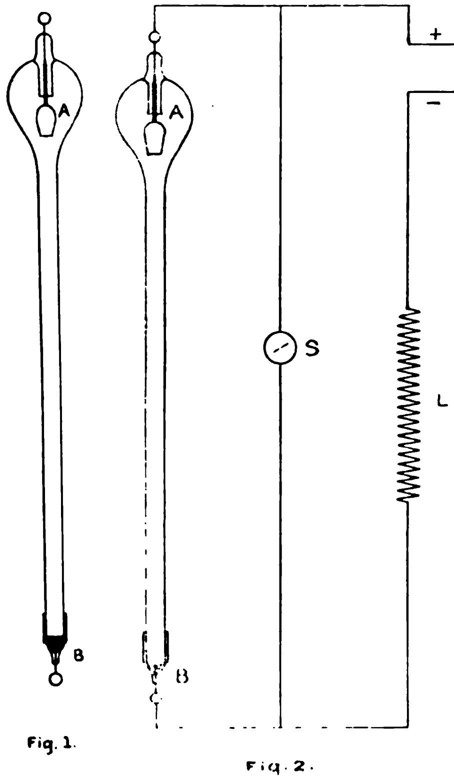


Fig. 1.

Fig. 2.

is a most thorough one; a chief difficulty here is in getting rid of the gases which exfoliate readily from the iron anode. This is overcome through heating the anode to a white heat while it is acting as the cathode under a high tension discharge. For a considerable time before the lamp is removed from the pump a continuous current sufficient to heat the lamp to a temperature of 200° C or 300° C is sent through it. This causes a steady stream of mercury vapor to flow from B towards A which carries along with it what of air and other gases may still be lingering within the tube. When the lamp is taken from the pump, sealed, and allowed to cool, there is practically nothing within it but mercury vapor under a pressure which is that of saturated mecury vapor at room temperature. Thus is a Hewitt mercury vapor lamp.

If a vapor lamp is to operate continuously it is necessary that the density of the enclosed vapor does not rise above a certain amount. This is accomplished by attaching a condensing chamber, of proper dimensions, which will condense the vapor at practically the same rate at which it is formed at the cathode. The condensing chamber for the lamp shown in Figure 1, is at the top of the tube about the anode; the connection current of mercury vapor ascending from the cathode rushes into this chamber and is condensed on its comparatively cold walls. This condensing chamber for ordinary lamps is about 3 cm. in diameter.

Concerning the operation of the lamp: a considerable difficulty occurs right at the start; for a while a lamp may have no objection to the conduction of a current which has somehow been started, it certainly does have a decided objection to the actual starting. Imagine a vertical pipe containing a column of water supported by a membrane constituting a bottom for the pipe; there is a force acting in the vertical downward direction which is iust equal to the weight of the column,

and tending to make it fall, and would do so were not the membrane capable of exerting an equal counter-force. Suppose the membrane to be suddenly jabbed with a brad-awl; the water flows now readily enough, although the force downwards acting upon it is the same as before; the resisting counter-force has, at least in part, been removed. In the vapor lamp corresponding to the counter-force of the membrane there is a counter-force of some sort at the cathode which must be banished before the lamp will operate on the difference of potential for which it was designed. (This difference of potential is usually in the neighborhood of one hundred volts.) To accomplish this result, in place of a brad-awl a wave of high potential is employed in a manner which will be evident after a reference to Figure 2. Before the lamp starts, the potential difference between A and B will be that of the mains, and, of course, no current passes from A to B by reason of the counter cathode force at B. Now let the switch S be closed. A current will quickly grow up in the inductance L, with its proper magnetic field about it. Suddenly open the switch and the energy of the magnetic field is suddenly transformed into that for a momentary high tension current in the circuit containing the lamp. This high tension current plays the role of the brad-awl in the analogy, by breaking down the high cathode resistance. The exact nature of this cathode resistance is still very obscure. The all important empirical fact, however, that the momentary high tension current is sufficient to reduce it from thousands of ohms to four or five, is perfectly well established. [It is this fact, coupled with another, namely, that a certain minimum current only is required to prevent this enormous resistance from immediately re-asserting itself, which forms the basis of the more recent inventions of Mr.

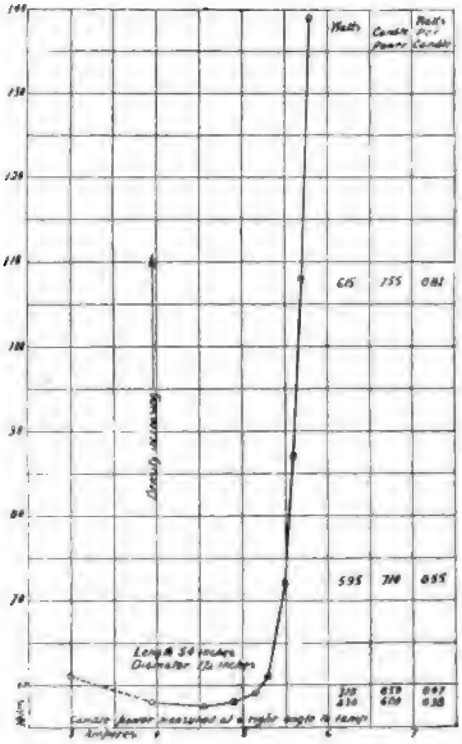


FIG 3

Hewitt.]

A reference to the curve shown in Figure 3 may prove instructive. The curve gives the relation between the drop over a lamp, while operating in a room at about normal temperature, 20 C, and the current. This characteristic curve has a minimum section which can be made very flat by properly assigning the condensing chamber. Along this flat section the cur-

rent may vary between wide limits and yet cause practically no change in the terminal voltage. Fortunately it is in this self-regulating domain that the efficiency of the lamp is greatest. An idea of the great efficiency of the lamp is obtained by referring to the numbers at the right. When the current gets fairly large the density goes up pretty rapidly and with it the terminal voltage and if there is a limit to the supply of the latter the lamp soon goes out.

normal light. It is rich in actinic rays, however, and very suitable for all kinds of photographic work.

The Hewitt Static Converter.—This device is essentially a Hewitt lamp, and the principle of its action depends upon the cathode resistance mentioned above. Its action can be most easily understood by considering it in connection with a single phase current.

Referring to Figure 4, D is an alternating current dynamo; C, the con-

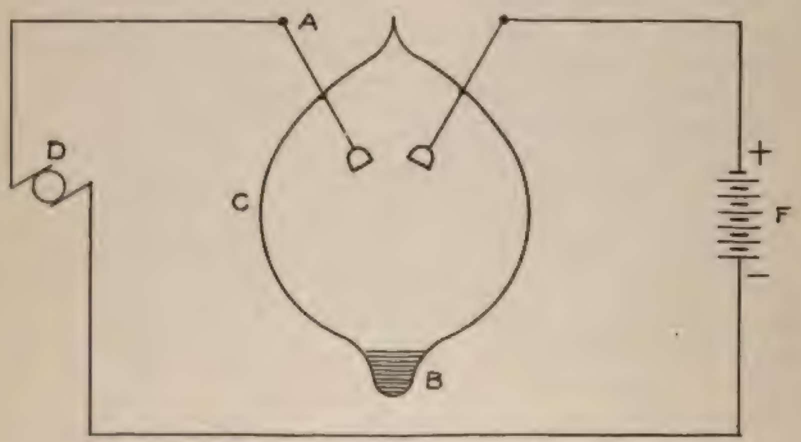


Fig. 4.

Concerning the effect on terminal voltage of varying the length and diameter of the tube: it increases directly with the length and with some inverse power of the diameter, probably not far from the first; more accurate experiments bearing upon this latter point are now in progress.

The great drawback of the Hewitt lamp is the color of the light it emits. It is quite lacking in red rays, and there is, of course, a very noticeable distortion of color values for all objects reflecting these rays under

verter with the mercury electrode at B; F is a battery or other source of direct current suppy capable of giving one or two amperes at about twenty volts. The function of this auxiliary source of supply is to keep down the cathode resistance at B, as explained above. If the E. M. F. characteristic of the alternator be a sine curve, then the current characteristic will consist practically of intermittent half waves which all lie on the same side of the axis of zero current; that is, the characteristic represents an inter-

mittent direct current. The reason of this is clear if one reflects that, with reference to the alternating E. M. F., A and B take turns at being anode and cathode; when A is cathode no current can pass from B to A for the high cathode resistance at A objects; not so, however, when B is playing the cathode role, for then the high cathode resistance is non-existant in virtue of the direct current from F.

The converter may also be operated on currents of higher phase and the auxiliary direct current may then be done away with.

The Hewitt Current Interrupter.—Perhaps the most important of Mr. Hewitt's recent inventions is the current interrupter. This is nothing more than a mercury vapor lamp with two mercury electrodes. This device is designed to replace the ordinary spark-gap over which it has many practical advantages. In the first place the ordinary spark-gap absorbs a considerable amount of energy, and moreover its action is liable to irregularities subject to the conditions of the sparking points or surfaces. These disadvantages disappear upon the substitution of the Hewitt interrupter. It is clear, of course, that the action of the interrupter depends upon the rapid appearance and disappearance of the high cathode resistance in a manner quite analogous to the variation of resistance in the ordinary spark-gap. The Hewitt interrupter seems destined to play a very important role in the future development of wireless telegraphy sending apparatus.

There is another and very important light in which the Hewit vapor lamp may be viewed and this is as an instrument of scientific research. To appreciate the truth of this one has but to reflect that the great advances in physical knowledge today are being made through the study of electric discharge in gases. To mention only one or two of the results of such study; it seems now most probable that inertia itself, that most fundamental property of matter, is in reality an electromagnetic phenomenon; the atom of Hydrogen has been proved to be quite a large bit of matter in comparison with electrons of whose existence we have now quite definite proof; recent work in Germany has shown that an electromagnetic theory of matter is quite within the range of possibility. Maxwell himself long before such results as these were more than dreamed of, strongly emphasized the importance of the study of the behavior of electricity passing though gases. The mercury vapor lamp with its adaptability for use with large currents ought to prove a valuable instrument in furthering the pursuit after facts of the most fundamental importance in connection with modern scientific notions—*The Tufts Engineer.*

Hundreds of electricians are at this moment striving to construct lamps in which nothing is consumed save the electrical energy applied to them—lamps that have the radiance of the sun and the coldness of the moon.

The United States has granted 3,-500 patents to women.

Automobile building gives employment to 20,000 persons in France.

trains. Robert Stevenson, who was the most eminent engineer of his day in England, became interested in the project and undertook to solve the problem. It was necessary to span about 1,400 feet in all, and it was decided to make two spans of 460 feet and two of 230. Up to this time trussed bridges in the modern sense had not been built and Stevenson conceived the idea of making a huge tube through which the trains could pass.

Of course, nothing was known concerning the economic depth, the amount of material required, or its distribution, but it was decided to make it about thirty feet high, thirteen feet wide and wrought iron plates, angles and tees, were selected for the material.

A model tube was next constructed, one-sixth actual size in every dimension. This was subjected to twenty-five experiments, and as any part failed it was replaced by a stronger piece. At the twenty-fifth experiment it totally collapsed carrying a load of 193,000 lbs.

The final structure now known as the Britannia Tubular Bridge was designed by means of a formula derived from these experiments, and successfully served its purpose for many years, but was very uneconomical. Only one other important example of this type was ever built, the Victoria Bridge at Montreal, and this was much lighter than its predecessor. Yet the Victoria Bridge cost almost three times as much per foot, ($1,100 and $388 respectively) as the Lachine trussed bridge erected near it in 1888.

At about the time of Whipple's publication, the building of trussed bridges rapidly increased. Many different forms were tried but the law of the survival of the fittest has eliminated all but a few.

For short spans up to 250 feet, the Pratt and Warren styles have maintained their superiority and are still largely used. They are both trusses with a single system of bracing; the Pratt has vertical compression pieces and inclined tension pieces, while the Warren has both compression and tension pieces inclined.

In bridge work, beams or stringers carry the loads to the floor beams, which in turn carry them to the points of intersection or panel points of the trusses. Now stringers cannot be economically designed longer than twenty or twenty-five feet, and this fact has hitherto limited the panel length of Warren and Pratt trusses to about 25 feet, which in turn limits their economical span to 300 feet at the most. The Whipple truss has a double system of web bracing and with the same panel length as before can be made of twice the span of the Warren or Pratt trusses.

For this reason the Whipple truss has long been a favorite for brdges of span from 300 to 500 feet, and many of the finest examples of American truss work are built in this form, such as the Cairo and Cincinnati bridges, both of which have over 500 foot spans.

The Whipple truss has now been largely superseded by the Baltimore and Petit trusses.

The Baltimore is similar to the Pratt but has short sub-verticals and ties or struts, which makes it possible

Double-track Through Bridge over the Missouri River at Bellefontaine, Mo.

to obtain both the short panel length and the long span. The Petit truss is similar to the Baltimore except it has a curved upper chord approximating the parabola in form, which causes all the top chord stresses to be nearly uniform. The bridge plate shows one span of the double track bridge over the Missouri at Bellefontaine, Mo. The trusses are of the Baltimore type, and although it is not an exceptionally long span, yet it is an excellent illustration of the principle of sub-panelling and gives a clear idea of the latest development in simple truss design.

In 1847 a light highway suspension bridge was erected at Niagara, but soon after, in 1855, this was replaced by the first suspension bridge for railroad traffic. Roebling, the engineer, found that many able English engineers believed his scheme to be not only impracticable, but impossible; yet he proceeded with its construction until success vindicated his judgment and ability.

It is interesting to note the fact that this bridge was several times successfully repaired without interruption of traffic, until scarcely a single piece of the original structure remained.

Traffic rapidly increased, however, and finally after forty years of successful service the suspension bridge was replaced by a steel arch of 550 feet span, again without any interruption of railway traffic, although up to this time, it was the largest arch for railway traffic in the world.

It was built out from the abutments, piece by piece, from each end, until the two parts exactly met at the centre, completely enclosing the old suspension bridge and finally displacing it entirely. Nearer to the falls is the newest of the Niagara bridges, the Clifton arch. This is built for highway traffic only, but it has the distinction of being the longest arch of any kind in existence. There is also another famous bridge near this, the 470 foot Cantilever, erected in 1883, for railroad purposes.

In the words of a noted engineer, "The four great bridges across the Niagara River gorge stand as an epitome of American bridge engineering."

After his successful completion of the Niagara bridge, John Roebling was naturally chosen to direct the design and construction of the great suspension bridge between New York and Brooklyn. This is probably, the most famous engineering work in America, and has indeed been justly regarded as one of the wonders of the world.

The new East River bridge now under construction, will not only eclipse its famous predecessor in span, size and cost, but will possess the greatest load carrying capacity of any sctructure in the world. Two immense steel towers, 1,600 feet apart, and weighing 6,000,000 lbs. each, will rise above the river to a heght of 335 feet. Suspended from these by massive steel cables, there will be 16,000,000 lbs. of steel, hanging over the river in mid air, with an added capacity of 9,000,000 lbs. more of live load.

The ends of the cables are imbedded in masonry anchorages which reach the tremendous amount of 250,000,000 lbs. at each end. Two separate masonry piers are provided for

each tower and together carry to the foundations over 100,000,000 lbs. This load is carried down through one hundred feet of water, mud, sand and clay, to the solid rock, by means of gigantic caissons or timber diving bells. These were floated into position and gradually lowered to the required depth. In order to prevent the water from flowing in under the edges, powerful compressors were used to constantly pump air into the working chambers, while great quantities of concrete were deposited in the caissons to keep them down. Large tubes were lowered into the caisson and through these, the mud and smaller stones were rapidly carried up and over the sides, by the tremendous air pressure in the caissons. Thus the men working in the chamber were gradually lowering the whole to solid rock, while others were building masonry on top, causing the foundation to grow in two directions at once.

The Firth of Forth cantilever with two spans of over 1700, feet is the largest bridge in the world, but its ability to carry heavy moving loads is considerably less than that of our new East river suspension bridge.

The English structure also affords a striking illustration of the differences in design and erection, here and abroad.

In America, bridges are usually built in the shop, piece by piece and are riveted together for the first time at their final resting place, where everything goes together like clockwork. In England, on the contrary, the old methods still prevail to a large extent, and in the case before us an entire bridge plant was erected near the site of the bridge, where the separate pieces were built one by one and fitted into place as the progress of the work required. There is also a great difference in appearance. The main members of the Forth bridge are cylindrical tubes, twelve feet in diameter and the large size of these gives the structure an appearance of great strength and massiveness, especially when contrasted with our much lighter appearing work, which is somewhat misleading.

The American design is usually quite as strong, more economical of material, and full as pleasing to the eye.

A recent French work of great interest, the Viaur Viaduct,* is now the largest arched span for railway traffic in the world, being 722 feet between end pins. In general appearance it bears a much closer resemblance to recent American work than anything lately built by either English or German Engineers.

It is indeed very similar to an arch recently designed and built by Theodore Cooper in Porto Rica, but differs from it in the important fact that it has three hinges or points of articulation, one at each abutment and one at the crown. In the Porto Rica bridge the pin at the crown is omitted, which makes it impossible to determine the stresses by the principles of pure statics alone, and requires the use of the elastic theory, enormously increasing the amount of mathematical labor involved.

Theoretically the two hinged arch possesses the advantage of being stiffer and also of being about ten per

cent. lighter.

The disadvantages are due to the indeterminate character of the structure, to the large temperature stresses, and to the great care required in erection, especially in providing solid and immovable abutments. In many cases of two hinged arches a movement in the abutments of even a few inches may cause such variation in the stresses as to nullify the value of the original computations.

Neither of the latter objections obtains against the three hinged arch, and many able engineers believe that its theoretical disadvantages disappear when practice is joined to theory.

In other lines of bridge work progress has been in the direction of simplicity, and as the Viaur Viaduct is also a step in this direction, it will be instructive to note how this structure will fulfill the condition of rigidity under heavy railway traffic.

Although the Viaur arch is an apparent exception, yet on the whole, European, and especially German engineers are inclined to use the more complicated and indeterminate structures, involving assumptions and refinements of computation which the actual case would hardly justify; whereas Americans have usually adhered to the simpler and more determinate forms.

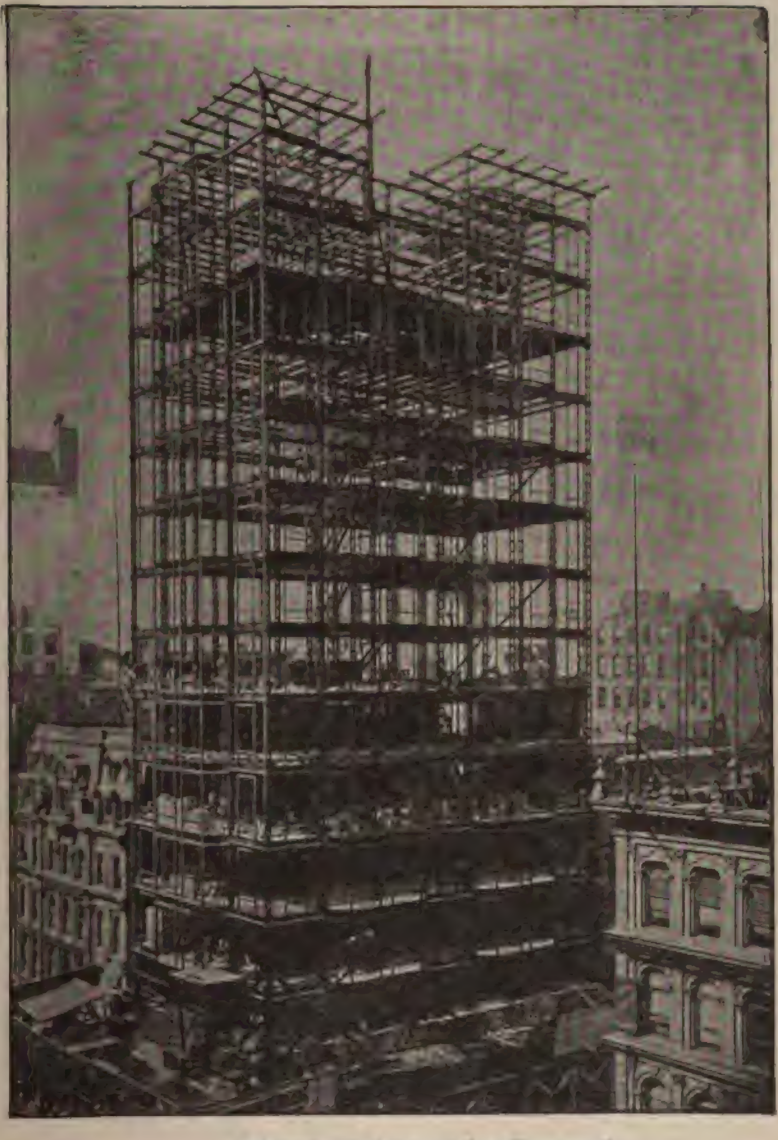
In Europe, on the other hand, engineers have long endeavored to give their structures a fine architectural appearance, while in America until recently, utility and economy have been the predominating considerations. The resulting effect in many cases has been to build structures with a monotonous repetition of straight lines and dull detail, content if only the engineering features of strength and stability are satisfied. It is, however, agreeable to note that we are beginning to offend much less in this particular.

The newer structures of the arch and suspension forms especially, with their light appearance and graceful curves, are quite susceptible of artistic treatment and this is being recognized in practice as well as theory.

The Washington arch in New York, though severe in form and unpretentious in ornament, is a gratifying success in this respect. And here in Boston, there is the new Cambridge and Boston arch, now under construction over the Charles river, which promises to rival in architectural effect the best previous work of its class even in the old world.

When, however, we come to consider cheapness of manufacture and rapidity of construction we find that we have already left all our rivals far in the rear. With about 200,000 miles of railway, there are in the United States about 65,000 bridges. The steadily increasing weight of engines and trains has made necessary constant removal of old bridges and rapid construction of new ones. This has occurred to a much greater extent here than abroad and accounts in large part for our facilities.

Structural and bridge engineering has assumed such large proportions, that great specialized plants with expensive machinery are growing up where improved methods of manufacture are continually being discovered and adopted. In the United States no important bridge shop is



Reliance Building, during Construction.
Aug. 1, 1894.

now without a complete equipment of travelling cranes by means of which heavy masses of material are quickly and easily moved from one spot to another. A recent traveller abroad found in France, and even in England and Germany to a lesser extent that "handling was done entirely by main strength and awkwardness."

Here, the engineering department including the drafting room, is considered the brain of the establishment. When a great piece of work is under way, the future must be discounted. Every contingency must be foreseen and provided for. Not a piece is made until the drawings for it are complete. Every separate piece has its own number and the position of the number on the drawing indicates where and how this unit shall become a part of the completed structure. When the engineering department has finished a given set of designs, drawings, construction and stock lists, it is safe to say that the amount of thinking required of the workman in the shop has been reduced to a minimum.

Sizes and shapes of material and even details are standardized. Every engineer of experience understands shop practice and consequently new work does not usually exhibit any strikingly strange or awkward construction. Thus it is that the engineers and builders are working together harmoniously with successful results as to economy and rapidity.

European engineers are not, as a rule, in touch with shop methods. In England, at least, according to "Engineering," "it has been the custom for each engineer to design his own bridges with the main object of making them somewhat different from every other engineer's design." The result is obvious.

Considerable amounts of bridge and structural exports have been made from this country within a few years and, as an illustration of what modern American methods are able to accomplish in competition with English conservatism, it may be instructive to mention one or two recent contracts let to American concerns.

The Atbara bridge, Africa, was let to the Pencoyd Steel Co.; 622 tons at $53 per ton; erection in fourteen weeks. English bid $79 per ton; erection thirty weeks. The Gokteik Viaduct, India, was let to the Penn. Steel Co.; 2260 feet long, 320 feet high; 4322 tons at $75 per ton; erection one year, English bid $106; erection three years. The Uganda Viaduct, 7000 tons was let to the American Bridge Co. at $90 per ton; erection forty-six weeks. English bid $108 per ton; erection in one hundred and thirty weeks.

A discussion of this subject would be incomplete without some mention being made of that important branch known as architectural engineering.

It is difficult to say when steel was first used in building construction but a very interesting structure known as the Bank of the State of N. Y. Building, erected about 1855, has been recently torn down.

In this building, the entire floor framing was made of wrought iron. This was before the advent of rolled sections, and the plates were made of plates and bars riveted together in approximately the same form as the present I beam. Aside from the inter-

esting methods used in overcoming difficulties of framing, this work, uncovered in the spring of this year, affords valuable testimony as to the durability of steel in building construction. After forty-eight years of service the metal was found in almost perfect condition and the names of the builders could be read in the original paint put on in the shop.

This is only one of several buildings recently demolished and as in this case the iron has usually been found in a good state of preservation.

Portland cement and concrete have been found to be almost perfect preservatives of steel, either from moisture or fire, and little fear need be felt when these materials are used to cover the metal.

In general it may be said that the preservation of metal depends upon our meeting the special conditions of each case, and the conditions are such that we are usually able to meet them by using proper care and foresight.

In the earliest examples when iron was used in buildings the floors were carried by iron beams to the walls, and the walls in turn carried their weight, and their own, to the foundation. At a later period interior columns were introduced but, based on false ideas of strength and economy, were usually made of cast-iron. Steel columns have now superseded cast iron ones, in large buildings, at least, and skeleton construction has been largely adopted for important office buildings.

Skeleton construction implies the use of steel as the sole supporting material where the floors, partitions and walls, even, are all supported on the metal frame. The adoption of this method is due to its great saving in floor space. Formerly, high and massive buildings required heavy masonry walls, often ten or fifteen feet thick, which very materially reduced the rentable floor space, especially in the lower stories. In skeleton construction the walls need not be over twelve or eighteen inches.

In localities where the soil is soft, wet, and full of quicksand, as in Chicago, steel is also used for foundations in the shape of large rafters of steel beams imbedded in concrete. In Chicago the soil is so soft that the first story is usually started nine or ten inches above its intended elevation so that the full load of the completed building will bring it to the proper level. This fact necessitates very careful designing in order to have the foundation areas proportional to their loads. This fact was lost sight of in the Old Post Office building, and an actual settlement of twenty-four inches at one point eventually caused its abandonment. One of the plates represents a typical skeleton frame before the walls were built in, and was taken from a photograph of the Reliance Building, Chicago, during erection in 1894.

In closing we find that Bridge and Structural Engineering has reached a condition of comparative completeness during the preceding sixty years. There are but few problems that the modern engineer cannot readily solve, and almost no service that steel in some form will not perform.

Experience has shown that plate girders are the most serviceable for railway traffic up to about 100 spans.

Pratt and Warren trusses, are the best for spans from 100 to 250 feet and Baltimore and Petit trusses the most economical from 250 feet to about 500 feet. Arches and cantilevers have decided advantages in many cases of peculiar difficulties, cantilevers being economical in spans from 500 feet to 1200 feet, while suspension bridges are probably the best under ordinary conditions for spans over that amount.

Simple and determinate forms of trussing have survived in the kinds mentioned; while complicated and indeterminate forms have disappeared.

In architectural engineering we have created vast buildings which tower hundreds of feet in the air and safely and economically house thousands of business men and women on small areas of ground.

Evolution of form and the survival of the fittest will undoubtedly continue to work important changes, yet it can almost be said that engineers are awaiting the discovery of a newer and better material than steel in order to show any great or startling changes.—*"The Tufts Engineer."*

Railway Construction.

The operation of the suction dredges used by the government in river and harbor work is very interesting. A long, flexible tube 12 to 15 inches in diameter drops down from the side of the vessel 20 to 30 feet or more to the bottom of the river or harbor upon which the dredging is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump, making several hundred revolutions a minute and capable of handling many hundred tons of water an hour. The lower end of the tube is manipulated from the vessel against the sandbars and mud banks, and as the water is sucked upward by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pumps discharge this water with its suspended material into the tanks on board the vessel or into scows, where the heavy matter quickly settles to the bottom, the water flowing back into the sea.

Suction Dredges.

In 1857 an American named Collins first proposed a railway from the Amur to the village of Tchita. Later, several plans were formulated, but it was not until March 17, 1891, that the Trans-Siberian railroad was definitely determined on and projected by an imperial order. On May 19, 1891, the first stone was laid. The line covers 3,562 miles in Russian territory and 1,604 miles in Chinese territory. In ten and one-half years 5,166 miles of rails were laid. In the Canadian Pacific, constructed under similar conditions, it took ten years to lay 2,921 miles of rails.

Lorain, O.—The B. & O. is completing one of the most inexpensive and unique coal loaders on the lakes. At a high place along the river bank the coal will be dumped onto an endless belt, which will convey it into the boats. It will also be one of the quickest loading plants.

ILLUSTRATING.

Descriptive Designs of Wall Paneling.

Ancient and Modern Decoration in Art.

BY CHARLES C. RIESTER.

THE ancient Egyptians—Egypt, the land of wisdom—Egypt of all other nations seemed to have designed and planned decorative art of wall antiquities to the best available models of strength.

Their design was rather in the permanence of construction, than for an artistic point in decoration. They used the most exclusive regard for the strength of their creative designs. There was a dim, bewildered instinct, a yearning of immortality always manifested in all their undertakings. They preferred for the art an unconscious existence in the form of hideous mummies to utter dissolution. They feared that the bodyless spirit might lose its personal idea, and expected or wished, after the expiration of the great cycle, to find all their great deeds, just as they had left it, exactly so without change, without decadence—the same bodies in their design and strength, the great obelisks pointing at the stars, their great pyramids and sepulchers; a strange faith, that they thought the soul after all varieties of an untried being should return into one of these strange and prehistoric idols and mummies to animate them. The Nile itself could tell a wondrous tale regarding these reminiscences of priest crafts and the mummeries of a perished creed.

From Egypt we have but to turn a page and we have the Greek, the Gre-

Ancient Greek Figure.

cians so different, yet a slight similarity to that of Egypt. They in all their art and design only worked for the beauty, and where beauty always pre-

dominated, the classic Greek is the ideal, from whence all beauty springs is a reality, so fair their forms, so neat their arrangements, so colossal their magnificent columns, and all in all, we have Greek as the master of all art and science. Their exquisite imaginative creations were the outlines of fairness, forms such as Venus and Apollo were common to the Grecian citizens. Expression and character were their chief aims in all their arts. Characteristic portrayals of pain, joy, sentiment and thought were visible in their work.

In my illustration of ancient Greece I have tried to convey a dim recollection of the Grecian greatness in art. You will see an ideal woman in all her beauty, as only Greeks loved to see woman, her whole expression denoted one of beauty, languidly poised, so as to enrich her exquisite features. They were numerous in all the homes of the classic Greek. Great pillars and fountains marked the interior of these dwellings. We, in our time only are imitators of the art and design which predominated and beautified all ancient Greece, Egypt and Rome.

The Romans merely imitated the Greeks, their masters in all arts. The unimportant changes they undertook to make cannot be said to be improvements.

After describing the decorative art of the Greeks, I pass on to the middle ages, when heraldry sprung into its use. In the eleventh century the use of heraldry was installed for decoration of wall panels. Heraldry consisted of armor, shields, helmet, battle axes and lances used by the leader of the crusades, and devices which marked noted leaders on the field of battle. The different possessions of the warriors were valued by their followers as being in so close a connection with his personality that they used them for wall decoration in every conceivable form. This lasted from the eleventh

Heraldry in the 11th Century.

century until the middle of the sixteenth century. During this time the use of heraldry was greatly developed with a high standard of artistic panel and wall decoration, certain changes have been made until the strength of heraldry came to a close in the sixteenth century.

The illustration presented herewith

is an example of the style which was greatly used in those changeable times. Very unique and would certainly be a good decorative design for use in one of our modern "dens."

You will note the battle axes crossed under the helmet which is

The Colonial of our Forefathers.

hung on the face of the shield; the center of the shield has the emblem of the crusades, the cross being their mascot on one side. When the great religious strife was being waged: under the shield on a small panel you will see the inscription which is in Latin, "*In Hoc Signo Vinces,*" which means, "*In this sign thou shall conquer.*" You will note my pen sketch the lance, which is in the background, on which there is a remnant of the color borne by the warrior. The draftsman who may make use of heraldry for decorative purposes will do well to study the different styles and

A Modern Antique Panel.

suits of armor, some times armor cloth, as may be the period.

Now we will proceed with some of the modern designs used. All the artistic decoration in wall panel design is, I may say, a mere repetition of the old, but before going farther on in our modern design, we turn to the colonial times of our forefathers. Nothing

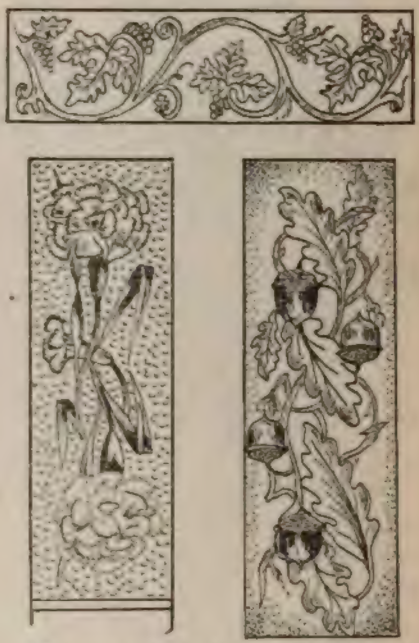
seems more homelike to us as the old surroundings, so simple in its simplicity, say a long common oak board with a few oblong panels carved at a convenient height, and an old Swiss clock, on each side a small shelf is constructed. To the left of the illustration you will see an old brass candle stick, on the right a few books, while perhaps in front of the fireplace, a neat woman humming a sweet song and rocking the infant into its peaceful sleep, while her hands are deftly spinning the flax on the old spinning wheel; but enough, and in place of sentiment I will make a few notes regarding our designs.

Then in the illustration entitled Modern Antique Panels, often used in ballrooms, halls, reception rooms, etc. The design is partially like those of the Greek, the scrolls and lion heads, the characteristic head at the bottom is also taken from the old style of decorations. In the center is placed an oval shaped mirror; the mirror should not be too high.

In speaking of our modern design, it is of little use to say more regarding the illustration I here present.

In the February issue of The Draftsman I have remarked the use of different flowers, leaves, acorns and grape designs that can be worked in wall paneling and decorative art.

In the illustration marked slight suggestions for panel design you will see carnations entwined with a sort of a hook stipple for the background. Then you will see the oak leaves and



Suggestions for Panel Designs.

acorns with a st ipple of dots for the background, the grapes and leaves made so as to work in a scroll-like appearance is very neat. The student may take any leaf, or more so, anything in nature's botanical gardens, you do not have to wish for any material, you have the whole world to choose from.

HOME STUDY.

Trigonometry Simplefied.

BY J. S. MYERS.

MANY persons when reading The Draftsman or other kindred technical matter find therein formulæ containing the abbreviations, Sin., Cos., Tan., etc. To one initiated they are no mystery, but, alas, far too many skim over these, saying to themselves, "Oh, that's trigonometry! It's too technical for me. I don't understand higher mathematics." This particular division of mathematics is, in fact, quite easy to grasp, even by the very ordinary mind. The writer has known boys in the drawing room to pick up in half a day the nucleus of the entire subject, which is merely the solution of a triangle. When one can do this he is able to successfully cope with most any problem arising in machine design or structural details.

It is not necessary to remember a myriad of formulæ about "side opposite" and "side adjacent." There is a simpler and easier method. Any one who can multiply and divide can solve practical problems in trigonometry.

There are six values to be known in every triangle, three angles and three sides. If any three of the values be known, one or more of these three known ones being a side, the other three can be determined. If all the three angles be known the relative proportion of the sides can be readily calculated. This is what is termed solving the triangle, and is nothing more or less in practice than simple proportion.

Take a triangle A, Fig. 1, and one B, Fig. 1, exactly like it, only larger. It is seen at once the sides C and D are twice as long as the similar sides on A; for if the side E be twice as long as the corresponding side on A, all the other sides are twice as long as there are corresponding sides on A.

Then $C = 2 \times 1.25 = 2.5''$ and $D = 2 \times 1.9 = 3.8''$. If this side E had been, say $6.3''$ instead of $2''$, then C would have been $6.3 \times 1.25 = 7.875$ inches, and side D would have been $6.3 \times 1.9 = 11.97''$.

In trigonometry we simply have tables giving the lengths of two of the sides when the other side is equal to 1, worked out for all angles from zero to 90°, and all we need to do is multiply to find the length of a side not known, or divide a known side by the side which equals 1 in the tables, and by referring back see what angle this quotient corresponds to.

These tables are worked out for triangles having one corner square, or equal to 90, i. e., they are right-angled-triangles. One side which may be considered the radius is equal to 1, the other two sides are named. All

that is then required is a sketch showing which side equals 1 and the names of the other two sides when they can readily be found in the tables by name. Tan. is read Tangent; Cot. is read Cotangent.

These values taken collectively are called *functions*. The above four are

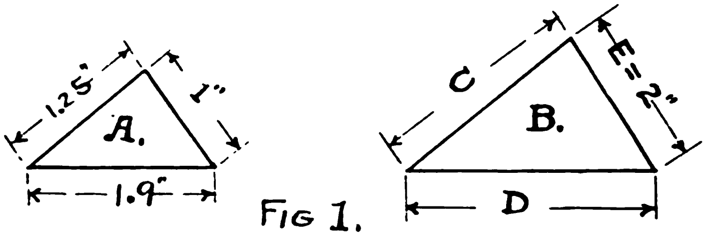


FIG 1.

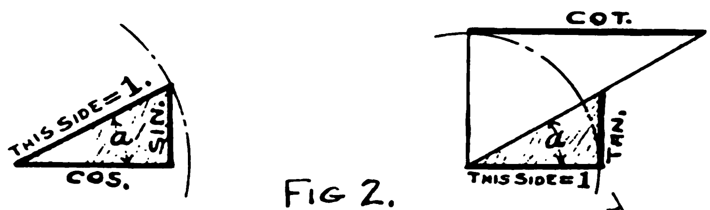


FIG 2.

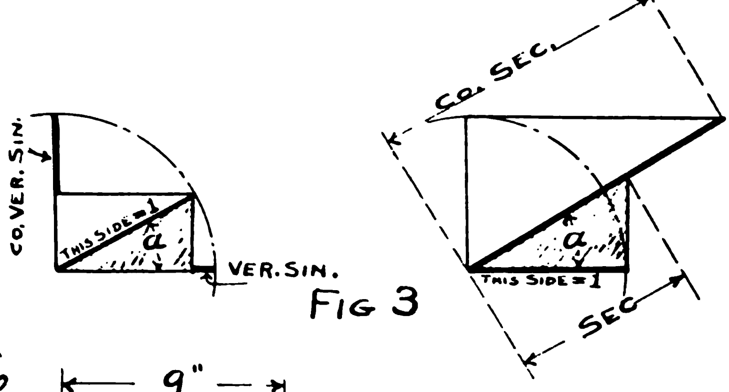


FIG 3

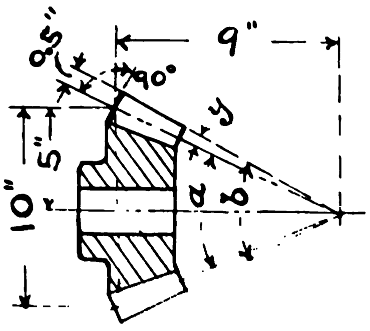


FIG. 4 a

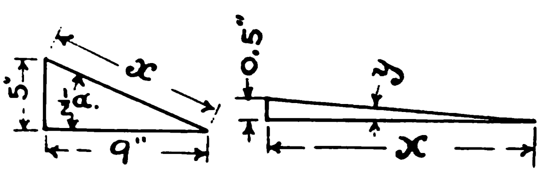


FIG. 4

Fig. 2 shows this for the usual tables with their abbreviations.

Sin. is read Sine;

Cos. is read Cosine;

sufficient to solve any triangle, but some tables give additional values, which are convenient at times, especially since it is easier to multiply than

divide. Fig. 3 shows these with their usual abbreviations.

Ver. Sin. is read Verse Sine;

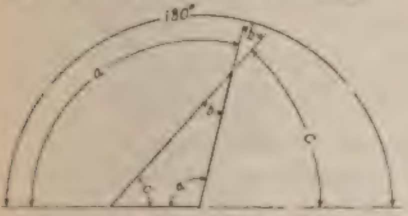
Co. Ver. Sin. is read Coverse Sine;

Sec. is Secant;

Co. Sec. is read Cosecant.

Since the tables are all for right-angled-triangles, one must always divide a triangle into right-angled-triangles for solution.

One more principal and we are enabled to solve most any ordinary problem in practice, which is, that the sum of the three angles in any triangle are equal to 180°. Any one can easily prove this to his own satisfaction by laying out several triangles of various forms and measuring the angles with a protractor, or, better still, by refer-



ence to Fig. 5. The truth of this statement is made so apparent that it needs no explanation.

By the use of this principle, when two angles are known, the value of the third can readily be found by subtracting the sum of the two known angles from 180.

Now for a practical problem:

A bevel gear 10 pitch dia. 2 diametral pitch meshes with another gear 18" pitch dia. Fig. 4a. What is the pitch angle and the face angle for turning the blank?

First find the pitch angle. We have the triangle A, Fig. 4, 9" base, 5" altitude. Referring to Fig. 2, the 5" side is seen to correspond to the side there named "tangent" when the 9" side=1. If the 9" side were 1, the 5" side to be 1-9 of what it now is or 1-9 of 5=5 ÷9=.5556, referring to a table of tangents this is found to be nearly the tangent of 29 degrees. The pitch angle a is then 2×29=58 degrees.

To get the face angle 6. find the angle y and add twice its value to the pitch angle. To get this angle we must first find the distance X. By referring to Fig. 3, it is seen this line corresponds to the secant, and multiplying the secant of 29 degrees by 9 gives the length X at once. In the absence of a table of secants we find that in Fig. 2 when this line is 1, the 9" line is the cosine and is given in the table as 0.87462 for this angle. Dividing 9 by 0.87462, we get X. 9÷0.87462 =10.29" nearly. This side X corresponds to the side which equals 1 in Fig. 2, and the side which is 0.5" corresponds to the side named "tangent." Dividing 0.5 by 10.29 gives the tangent of the angle y. 0.5÷10.29= .0487 nearly. Referring to our tables we find that this is nearly the tangent of 2 degrees—50'. The face angle is then 2×(2 degrees—50')+58 degrees —63 degrees—40' which is the angle for turning the blank.

A novel watch in Zurich is in the form of a ball which moves imperceptibly down an inclined plane without rolling. There is no spring, the sliding giving motion to the hands, and the trip from top to bottom of the inclined surface, a distance of sixteen inches, requires twenty-four hours. The ball is then lifted again to the top.

Hexagon Bolt Heads in Isometric.

O make a hexagon bolt head or nut, we take hexagon stock, square up the ends and chamfer off the corners; having, as a result, what is shown in Fig. 1. Bearing these facts in mind, it may be clearly seen that the first step in finding the isometric of bolt heads is to draw the hexagonal prism in isometric.

In Fig. 2 are shown two views of a hexagonal prism across corners. Draw the diagonal A D and connect the points C E and B F. On examination, it will be found that H D and A G are equal to one-fourth of A D.

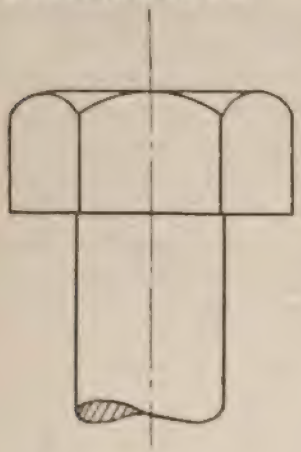


Fig. 1.

To draw the hexagonal prism in isometric, first draw the line A' D', Fig. 3, at an angle of 30 degrees with the horizontal, and divide it into four equal parts as shown. Through G' and H' draw the 30 degree lines B' F' and C' E' equal in length respectively to the lines B F and C E in Fig. 2, and making C' H' equal H' E' and B' G' equal G' F'. Connecting the points A' B' C' D' E' F' A', we have the isometric of the base of the prism.

Drawing vertical lines through the vertices of this hexagon and laying off

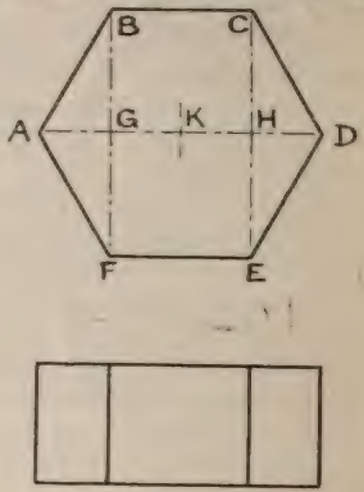


Fig. 2.

on these lines the altitude of the prism, we may complete the isometric drawing of the prism.

In Fig. 4 is shown this same prism

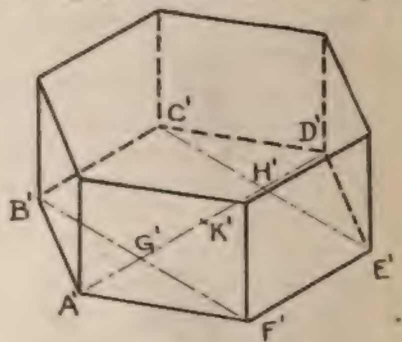


Fig. 3.

with the corners chamfered off, thus forming the hexagonal bolt head. To draw the isometric of this object, pro-

ceed as before only laying off on the vertical lines the lengths of the lateral edges of the bolt head. See Fig. 5.

To produce the curves in isometric, proceed in the following manner:

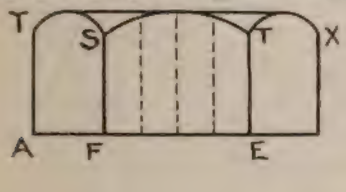


Fig. 4.

The surface S F T E is the true shape of all the lateral faces of the bolt head, and from this one all of the curves may be drawn. Divide the line F E, Fig. 4, into any number of equal parts, dividing the line F' E', Fig. 5, into the same number of equal parts. Draw vertical lines through these points of division. Lay off on the

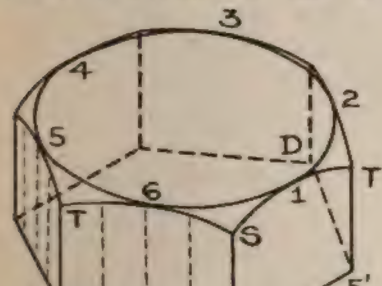


Fig. 5.

lines in Fig. 5, the lengths of corresponding lines of Fig. 4, and sketch the curve through these points. In a similar manner, the curves may be obtained on the remaining five surfaces of the head.

The isometric of the circle caused by chamfering the corners may, if the bolt head be small, be sketched tangent to the points 1, 2, 3, 4, 5 and 6. See Fig. 5.

If the circle be large and it is nec-

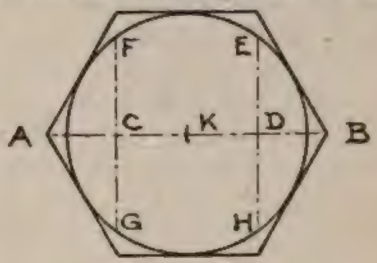


Fig. 6.

essary to obtain more than the six points already referred to, draw the top view as shown in Fig. 6, and divide the horizontal line A B into any number of equal parts. In Fig. 6 the line A B was divided into four equal parts, and the lines E H and F G were drawn.

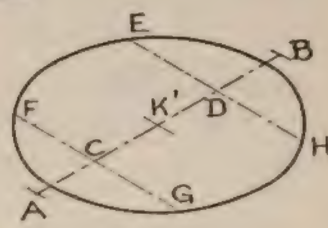


Fig. 7.

Making K' B' and A' K', Fig. 7, equal in length to K B and A K, Fig. 6, and dividing into the same number of equal parts, we may obtain the points E, H, G, and F by laying off the distances from A' B' equal to those in Fig. 6. More points may be ob-

tained by using more divisions of the line A B.

In all of the explanation thus far, we have considered that three of the lateral faces were visible in the orthographic drawing. If the position of the bolt head was as shown in Fig. 8, the principle is the same, although the

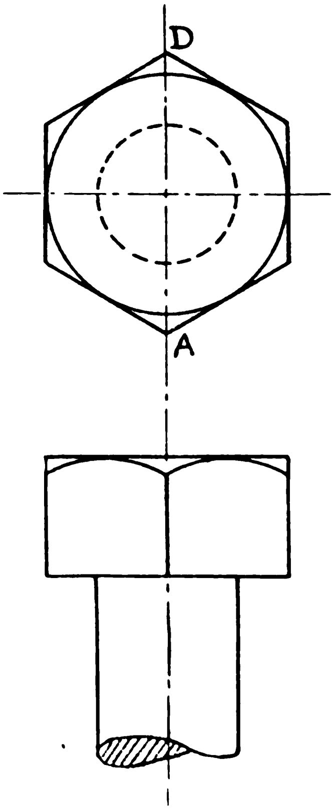


Fig. 8

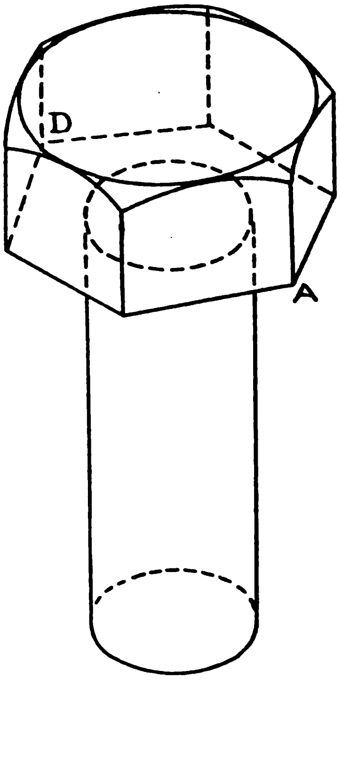


Fig. 9.

center line, A D, will occupy the position shown in Fig. 9, instead of the position A D, Fig. 5.

ARTHUR B. BABBITT,
Hartford High School,
Hartford, Conn.

Elementary Mechanical Drawing.

DEVELOPMENT OF SURFACES.

TO DEVELOP the surface of any given object is to make a diagram on some thin material, which, being cut out and bent or rolled into the proper shape, will inclose a space exactly equal and similar to that occupied by the given object.

The development of an object is thus a pattern, and all objects of sheet metal, from the simplest tin dish to the most complicated sheet-iron work in pipes, ventilators, boats, etc., are obtanied by means of such patterns.

When the form developed is to be

constructed of paper or sheet metal the outer edges of the development should be provided with projecting pieces called laps, by which the different parts may be held together.

In practical work, sheets of metal cut to the form of the development of the surfaces will shrink some when being bent and rolled into shape, so that a small allowance must be made for this defect.

In boiler and sheet metal work the amount of shinkage is considered to be about three times the thickness of the plate, but in this course we will neglect both the allowance for shrinkage and the laps.

These developments are often called "patterns," or "templates," and the workmen who make a business of laying out such diagrams are called "templet makers," or "layers out."

These workmen take the drawing of the object and develop it upon the material to be used, locating all holes and making allowance for laps and shrinkage.

In practice, the shape of the objects varies considerably, and often the surfaces are intersected by surface of a different shape, so that a further consideration of intersecting surfaces will be taken up with "development," or "pattern drafting."

The following plates take up a few plain and intersected surfaces, and show the manner of development.

PLATE XIV. Problem 1.

To develop the surface of a cube which measures 1½" on all edges.

Draw a plan of four sides which have their edges parallel, and attach them to each other, making a strip equal in length to the perimiter of the cube. Then to one of the faces so developed attach the two remaining faces. Place S 1" from the left and 2½" from the top border line.

Problem 2.

To develop the surface of a portion of a cone, the object being shown in Fig. 2, and the development in Fig. 3.

Since we are dealing with the surface of the cone, the slant height 1-3 is the radius of the development, 1′—3′ and 1—2 is the length for 1′—2′.

The length of the arc, 3′—4′ is equal to the circumference of the base circle and may be laid out with the dividers by stepping around on a circle of the size of the cone base, then laying off the same number of steps on 3′—4′.

Attach the base circle, "B," and top circle, "T," to the development of the surface. Locate 1′, 1" from top and 3½" from right border lines.

The cone is 3½" high, base 2½" in diameter and is located about 8" from the right border line, the base 3—4 being 5" from the top border line and 1—2 is one-half of 1—3.

Problem 3.

Lay out the development of a part of a pyramid as shown in Fig. 4. The circle of the base of the pyramid is 3" in diameter with A placed 2½" from the left and 6" from the bottom border line.

Locate B ¾" from bottom border line and make BC 3½" long.

Draw the hexagon showing the shape of the base in the top view and connect the corners with center A.

Project the points b and c to line DE and draw in the edges of the pyramid.

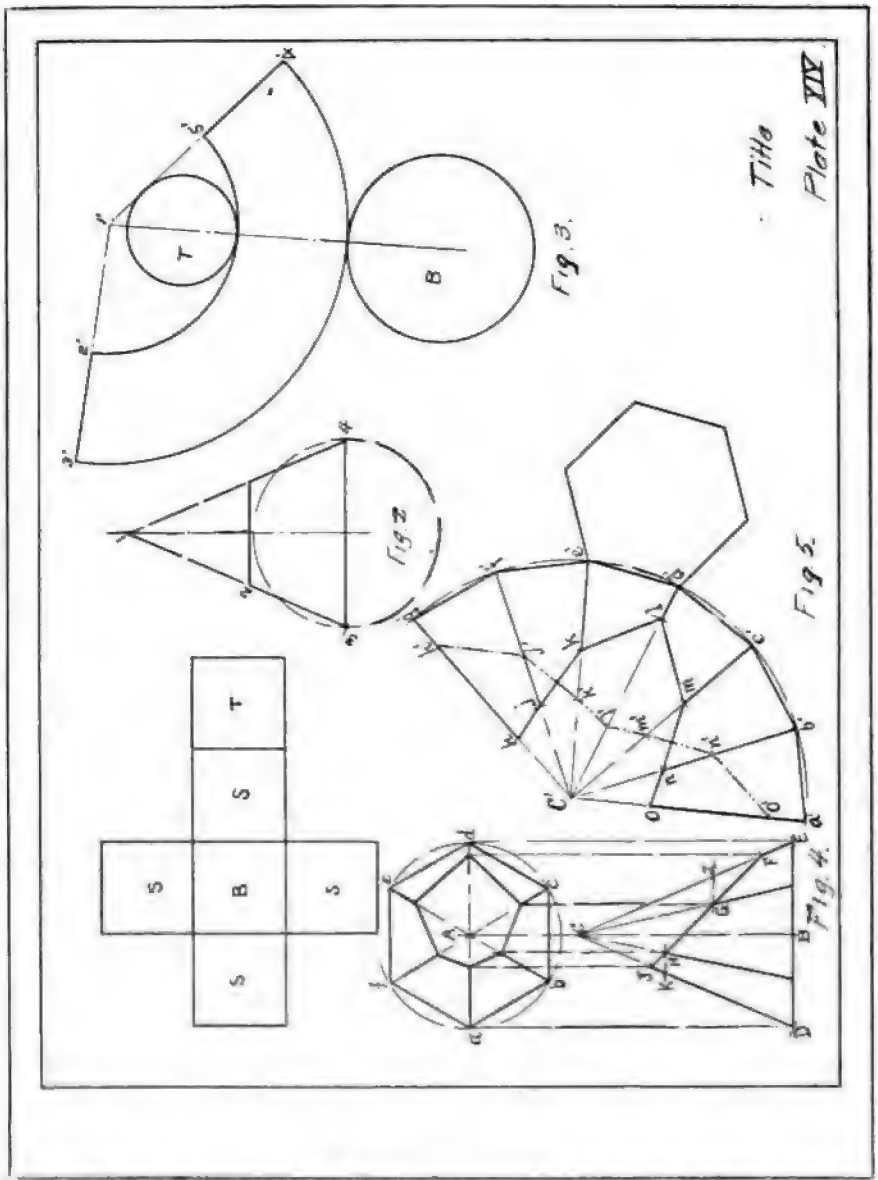
Draw line JF at an angle of 45 degrees, making EF ¼".

Locate C' 4¾" from left border and 4¼" from bottom border line, and as in the case of the cone, Fig. 2, C' a' is equal to the *slant* height CD and is the radius for the development in Fig. 5.

Step off on arc a' d' g' the lengths of the sides of the base, ab, bc, cd, etc., and draw in a' C' b' C', etc.

On C' a' lay off CJ and on C' b' lay off CK, which is CH projected to line CD. Then the heavy line figures a' o n m e k j h g f' e' d' c' b' a is the development of the surfaces of the pyramid, and the base may be attached.

The development may be reversed, laying off a' o' equal to EF, b' n' equal

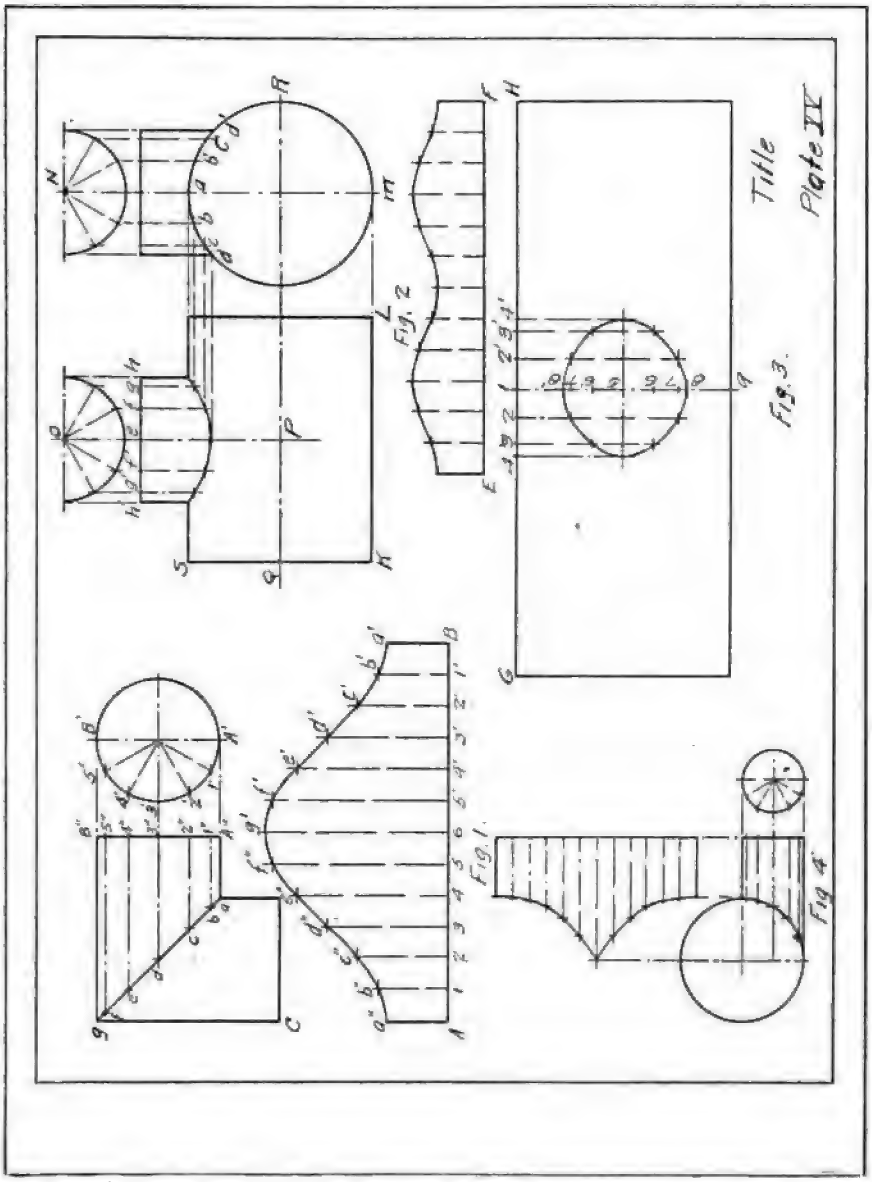


to EL, and so on, which would produce the figure bounded by the dot and dash line.

If the student put in the form as shown by the dot and dash line, he may have space for the shape of the upper face of the pyramid and this will be left to him to lay out.

(The circumference of a circle is equal to the diameter multiplied by 3.1416.)

PLATE XV. Problem 1.



Develop the surface of one part of an elbow whose diameter is 2″. C g and B″ g are each 3″ and are each 1″ from the border, the line ga making an

angle of 45 degrees with Cg.

Locate the center line d 3′ and draw the circle on line A′ B′, 1½″ from A″ B″.

Divide the semi-circle into an even number of parts and project point 1′ to A″B″ and draw 1″ b, and proceed the same with the other points.

Lay out the line AB equal to the circumference of circle A′B′ and divide it into the same number of parts as the circle. Then erect lines at these points and make Aa″=A″a, 1b″=1″b and so on until each element of the cylinder is laid out. Through the points a″, b″, c″, etc., draw a line with the aid of the French curve. Then the figure AB a′ g′ a″ is the pattern for both pieces of the elbow.

Problem 2.

Lay out the patterns for two cylinders of different sizes which intersect at right angles. The large one is 3″ in diameter and the small one is 2″ and extends 2″ above the center line of the large one. On the center lines MN and OP, draw semi-circles and divide them into the same number of parts, projecting the points vertically as shown.

Lay out EF equal to the circumference of the small cylinder and find points for the curve as in Prob. 1.

Lay out the rectangle G=HIJ with GH equal to the circumference of circle m Ra and GJ=KL, the length, which is 4″.

Line MN is 2½″ from the right border line and OR is 4″ from the top border.

From 1, the center point of GH, lay out 1—2, and 1—2″ equal to ab and ab′ and 2—3 and 2′—3′ equal to bc and b′c′ and 3—4 and 3′—4′ each equal to cd and c′d′ respectively. Also from the center of 1—9, lay off 5—6 and 5—6′ equal to ef and ef′, and 6—7 and 6′—7′ each equal to fg and f′ g′ and 7—8 and 7′—8′ equal to gh and g′h′ respectively.

Project from points 8, —7, —6, —5, —6′, —7′ and 8′ to lines from 1, 2, 3, 4 and 2′, 3′ and 4′ as shown and draw in the curve, which completes the developments.

Problem 3.

A 2″ cylinder set 2″ from the left border line has a cylinder of 1″ diameter intersecting it as shown. The side cylinder is 2″ long measured from the center of the large one and the center of the large one is 1½″ above the bottom border line.

The manner of laying out the pattern for the small cylinder is the same as in previous problems.

(To be continued.)

CURRENT TOPICS.

Device for Sharpening Pencils.

A device for use in sharpening pencils has been invented by Walter S. Doe, of Jersey City, N. J., which is simple and arranged to permit the use of the ordinary knife to cut down the wood and core of the pencil.

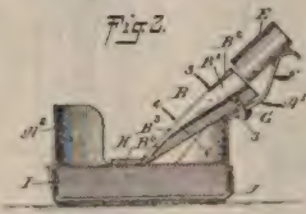
Fig. 1 is a perspective view of the device, while Fig. 2 is a sectional elevation, both views illustrating the manner of use quite well.

In the illustration it will be seen that the knife would probably strike the base of the cup, but a stop plate, H, made of lead or hard wood, is provided to avoid injury to the blade.

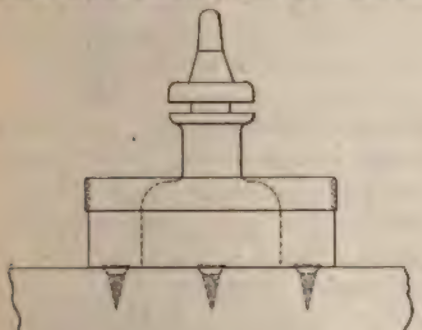
In order to enable the user of the device to readily sharpen the knife, a whetstone, I, is provided in the base, A, so that by opening the cap, J, it may be used and then covered again. The base of the device is covered with felt, so as not to mar the table.

Fig 1.

Fig 2.



The accompanying sketch illustrates an effective and satisfactory method of dealing with the draftsman's most contrary servant—the ink



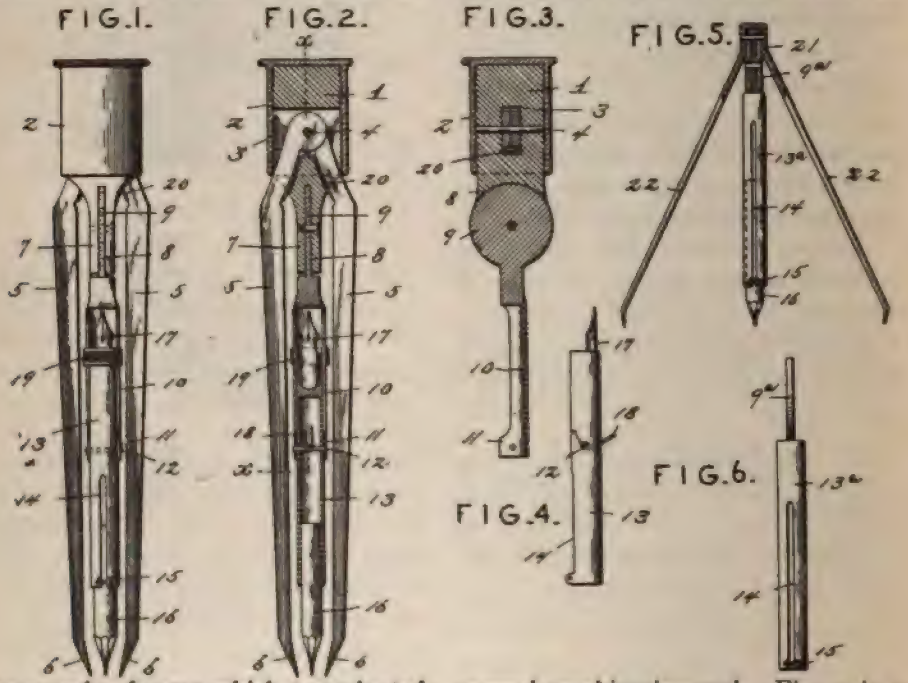
bottle. To your table or drawing-board screw an ordinary threaded-top tin box which is just the hight, or, better, a fraction lower than the body of the bottle; cut a hole in the top just large enough to force the neck through, assemble as shown and you will have an inkstand not only able to withstand tipping and sudden knocks, but which will always be found in its place when needed.—*R. C. in American Machinist.*

If THE DRAFTSMAN is as much better as it looks in its new coat of colors, it cannot fail to fill its chosen field to the absolute and complete satisfaction of all concerned.—*Book and News Dealer.*

Combination Tool.

THIS invention relates to a new and useful combination-tool adapted to be used by draftsmen for bisecting, drawing parallel lines, laying off angles, measuring distances, etc.; and its object is to provide a simple and compact device of inexpensive construction which may be readily employed for any of the purposes enumerated.

The invention consists in providing a head within which are pivoted the inner ends of arms which are adapted to be used as dividers, compasses, etc., and the head is provided at a point between these arms with an extension having a slot therein, within which is secured a revolable disk having an arm projecting therefrom. A sleeve is pivotally mounted within this arm and is adapted to contain a pencil at one end and a pen-point at the other. The disk before referred to is provided with suitable graduations upon the periphery thereof, whereby the arm of the disk may be turned at any desired angle.



The invention also consists in the further novel construction and combination of parts, which will be more fully hereinafter described, and illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of the improved combination-tool. Fig. 2 is a central vertical section therethrough. Fig. 3 is a section on line x x, Fig. 2, with the pen and pencil holder removed. Fig. 4 is a detailed view of said holder detached. Fig 5 is a similar view of a modified form of device, the upper portion thereof being shown in section; and Fig. 6 is an elevation of a modified form of holder.

Referring to the figures by numerals of reference, 1 is a cylindrical head having its outer face threaded and adapted to project into a cap, 2. A slot, 3, extends into the head from the inner face thereof, and pivoted upon a point, 4, in the center of this slot are the inner ends of arms, 5, having straight edges and terminating at their outer ends in pointed extensions, 6, projecting inward toward each other. An extension, 7, is formed at the inner end of the head, 1, and is arranged between the arms, 5, before referred to. This extension has a slot, 8, therein arranged in a plane at right angles to slot 3, and within this slot is pivotally mounted a disk, 9, having graduations upon the periphery thereof. This disk has an arm, 10, projecting therefrom and substantially U-shaped in cross-section, and ears, 11, project laterally from the end of the arms and are adapted to form bearings for the ends of a pin, 12, which project from opposite sides of a sleeve, 13. This sleeve has a longitudinally-extending slot, 14, in one end, and a clamping-screw, 15, is adapted to bind the slotted portion of the sleeve upon a pencil, 16, or other device which may be inserted thereinto. The opposite end of sleeve, 13, is adapted to contain a pen-point, 17.

A spring, 18, is arranged within sleeve, 13, and coiled upon pin, 12. One end of this spring bears upon the inner surface of the sleeve, while the opposite end extends through the sleeve and is adapted to bear upon the inner surface of arm, 10. This spring is adapted to force outward that end of the sleeve, 13, which contains the pen-point, and when it is desired to hold the sleeve in alignment with arm, 10, a ferrule, 19, must be slid longitudinally upon arm, 10, and over the inner end of sleeve, 13, as clearly illustrated in Figs. 1 and 2. A bow-spring, 20, is arranged within slot 3 and adapted to bear upon the inner edges of the arms, 5. This spring will force the arms outward when the cap, 2, is screwed upward upon head, 1. It is obvious that the arms, 5, will be automatically extended any desired distance from each other in proportion to the distance the cap, 2, is removed from the inner end of head, 1. The straight edges of these arms can be used as rulers. The graduations upon one side of disk, 9, are preferably so arranged as to indicate degrees, while those upon the opposite side of the disk indicate inches and fractions thereof. With this arrangement, therefore, the arm, 10, and the sleeve connected therewith can be moved any desired distance from the plane within which the arms, 5, are located, and this distance will be promptly indicated in inches upon the periphery of disk 9. The degrees of a circle can also be obtained in the same manner by referring to the graduations upon the opposite side of the disk. As the arm, 10, swings in a plane at right angles to the planes of arms 5, it will be understood that the same are always at equal distances from the two arms. With this device, therefore, the center of a circle can always be quickly and accurately located.

In Fig. 5 is shown a modified form of instrument which may be employed where it is deemed unnecessary to have both a pen and pencil for marking purposes. By referring to this

figure it will be seen that the sleeve, 13, has the central portion of a spring-strip, 21, riveted to the opposite sides of the ends thereof, forming a head, and the ends of this strip from spring-arms, 22, which are the equivalent of the arms 5, before referred to. The disk 9a is mounted within the end of this modified form and has a tubular extension, 13a, integral therewith for the reception of a pen, pencil, or other marking device. This form of instrument is adapted to be used in the manner described in connection with the device shown in Figs. 1, 2, and 3; but instead of employing a cap to adjust the spring-arms it is necessary to press them inward by hand. The disk and tubular extension, 9a and 13a, are illustrated in detail in Fig. 6, and, if desired, the graduations shown in Fig. 1 may be omitted from disk 9a. as shown in Fig. 6.

The inventor is Mr. Clyde R. Jeffords, Ithaca, N. Y.

Solar Energy.

All the energy of life is derived ultimately from the sun. A little of this comes indirectly through lightning, which, in passing through the air, forms ammonia and oxides of nitrogen. These, being carried by rain into the ground, are the constant source of nitrogen for vegetable, and, indirectly, for animal life. A much larger quantity of energy is well known to be taken direct from the sunshine by plants and used in their anabolic processes. This energy is appropriated by animals in their food, and whether in the vegetable or in the animal it assists in many alternations of the system before it is completely dispersed.

New Aid to Navigation.

In the ship-warning system of Mr. C. E. Kelway, signals by Hertzian waves are sent out from the lighthouse at regular intervals, at the same times as the sound warnings. A vessel in range having a receiver notes the time that passes between receiving the wireless signal and the sound warning, and is thus enabled to calculate its distance from the lighthouse; and on repeating the observation after continuing a few miles, data is obtained for ascertaining the exact location of the lighthouse by trigonometry. A stop watch reading directly in distances and a special position finder have been devised for use with the system.

Japanese Workman.

(Continued from page 97)

nation in all things, but at the same time the Japanese buildings, grounds, exhibits, etc., will inevitably possess a vivid local color of exceptional attractiveness,

From the attitude of the Japanese draftsman would lead one to think that their drawings would be much on the free hand order, though it is known that there have been hundreds of young men educated in this country to use American methods in that class of work.

Worlds Fair Pointers.

Polo will be a feature of World's Fair games.

Illinois will make a complete fish exhibit at the World's Fair.

Chattanooga, Tenn., will erect a $25,000 building at the World's Fair.

Germany and America will have competitive exhibits of forestry, each five acres in extent, at the St. Louis World's Fair.

A rose garden six acres in area and containing 50,000 rose trees, will be one of the attractions at the St. Louis World's Fair.

A model farm, representing a section of land 160 acres in extent will be one of the interesting and valuable exhibits at the World's Fair.

The leading painters and sculptors of St. Petersburg, Russia, have promised to co-operate in organizing a Russian art exhibit at the St. Louis Exposition.

The State of Maine Building at the St. Louis World's Fair will be unique in character, its motif being the log cabin, the walls constructed entirely of logs.

New Mexico will make an exhibit of turquoise mining at the World's Fair. A lapidary showing how the stones are cut and polished and prepared for the market will be a feature.

The British National Pavilion at the World's Fair, St. Louis, will be a reproduction of the orangery or banquet hall of the Kensington Palace, in Kensington Gardens, London.

The chief feature of the Cornell University exhibit at the St. Louis Exposition will be a plaster model, eight by six feet, of the campus. This will show the streets, buildings, gorges and waterfalls, all in color.

According to W. Kohlsaat, Commissioner of the Exposition to Norway, Sweden and Denmark, the Crown Prince of Sweden will attend the Fair, and his intimate friend, Crown Prince Frederick, may also come.

Curious Properties of Radium.

The properties of radium are extremely curious. This body emits great intensity all of the different rays that are produced in a vacuum tube. The radiation, measured by means of an electroscope, is at least a million times more powerful than that from an equal quantity of uranium. A charged electroscope placed at a distance of several meters can be discharged by a few centigrams of a radium salt. One can also discharge an electroscope through a screen of glass or lead five or six centimeters thick. Photographic plates placed in the vicinity of radium are almost instantly affected if no screen intercepts the rays; with screens, the action is slower, but it still takes place through very thick ones if the exposure is sufficiently long. Radium can therefore be used in the production of radiographs.—*Century.*

Not Drafting Instruments.

A pair of deviders.

Size of Panama.

Panama is not nearly so small as it looks on the map. The Carribean coast line is 450 miles long, and the bay of Panama is 110 miles long and 122 miles across at its mouth. The entire republic is twice the size of Switzerland.

"A San Francisco man says there are three kinds of flying machines."

"Well, what the public is waiting for is the fourth kind—the kind that will fly."—*Cleveland Plain Dealer.*

An elephant's jaw has been unearthed in Halleck canyon, Wyoming.

Thirteen new theaters, to cost $8,000,000, are building in New York city.

Animals have a language made up of signs or inarticulate sounds expressing impressions, sensations, passions, but never ideas. So this language excludes conversation and is limited to interjections or signs of movements expressing joy, grief, fear, anger, all the passions of the senses, but never more.

Unusual Sequel,

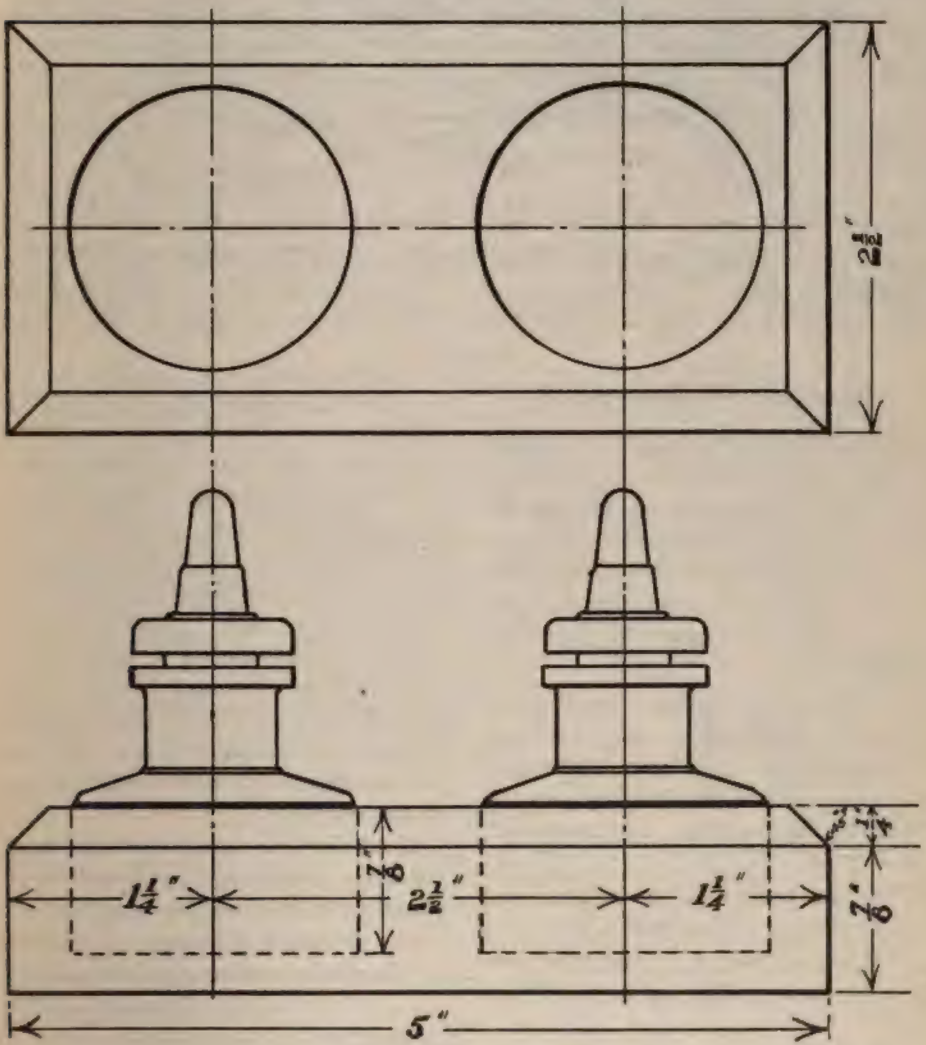
We came upon the inventor who was interested in sky navigation.

"Hello, old man," we greeted, "are you still working on that airship?"

"No," he sighed, limping away on his crutches. "I dropped out of it."—*Chicago Daily Mail.*

Double Bottle Holder.

A hard wood block of these dimensions will make a convenient holder f o bottles of ink of two colors.



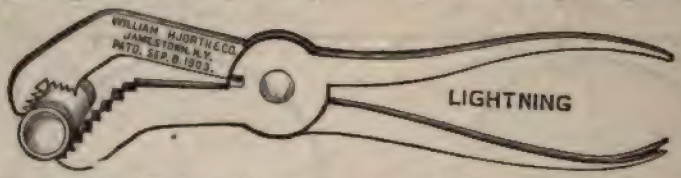
A New Paper Product.

Waste paper is used as the basis of a new composition which is said to be hardier than many kinds of stone. The secret is that of a Yonkers (N. Y.) man, who has given it the name of pollardite. As a thin veneer placed on iron, wood, stone or brick, it is said to offer protection against fire, water, acids or rust, resisting the effects of extremes of high and low temperatures. It is composed chiefly of waste paper pulped and molded into form, and presents the appearance of stone in color and consistency.

Combination Wrench and Plier.

This Wrench is a perfect Pipe and Nut Wrench combined. It takes pipe without crushing and is always ready a Wire Cutter, Screw Driver and Nail or Tack Puller.

Made of drop forged tool steel,



without adjustment. It is not neccessary to mash handles while in use on pipe or nuts, as pressure on one handle will do the work. It has slso properly tempered, highly polished an put up in good workmanship manner.

Made in four sizes by Wm. H. Jorth and Company, Jamestown, N. Y.

Books and Pamplets.

The long delayed authorized edition of Mr. S. P. Thompson's Dynamo-Electricity Machinery is by far the most complete work of the kind, and in latest editions embraces all the great changes that have taken place in this most important branch of Electrical Engineering.

It contains 996 pages, 573 illustrations, 4 colored plates, and 32 large folding plates, and the authorized American edition is published only by Spon & Chamberlain, 123 Liberty St., New York.

For the benefit of the student and young designer especially, a few facts and formulæ have been compiled in a booklet form on the subject of "Pulleys."

This contains information on speeds, belts, rims, arms, hubs and keys, and some remarks on fly-wheels, and is arranged in the order here named. It is printed on coated book paper, 6 x 9 in. pages, with 27 illustrations and several tables. Price, 25c. Address The Draftsman, Cleveland, Ohio.

We beg to announce to our many friends and customers, and the trade generally, that our corporate name has been changed to Lynchburg Foundry Company and as successor to the Lynchburg Plow and Foundry Co., we will continue operating the McWane Pipe Works, and Lynchburg Plow Works, manufacturing a high grade of Cast Iron Gas and Water Pipe, Chilled and Cast Plows, and General Foundry and Machine Work, with the best equipped and most modern plants in this country.

Thanking our friends for the past generous pattronage, and soliciting your future business, we are,

Very truly yours,
Lynchburg Foundry Company,
Lynchburg, Va.

For high-grade work requiring precision and excellence there is to be found in nearly every machine shop in Germany a group of American tools—a silent tribute to the remarkable position held in the world to-day by the American machine tool's work.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study,

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Can Ships be Rendered Unsinkable?

BY FRANK C. PERKINS.

ALL of the large steamers of modern construction are divided into watertight compartments by bulkheads. These bulkheads have to be pierced with openings in order to work the ship, passages being provided for the officers, firemen, engineers and passengers. These openings are fitted with watertight doors and, in case of danger, orders are issued for closing these bulkhead doors, rendering each compartment watertight and secure.

Should anything prevent the closing of the bulkhead doors the entire equipment of the ship's hull, with watertight compartments, would be of no use, and there is a large list of disasters arising from the failure to close these openings.

The accompanying illustration, Fig. 1, shows the hydraulic accumulators, and drawing, Fig. 2, shows the apparatus of the Stone-Lloyd system for closing all of the doors in a ship in a few seconds, either collectively or

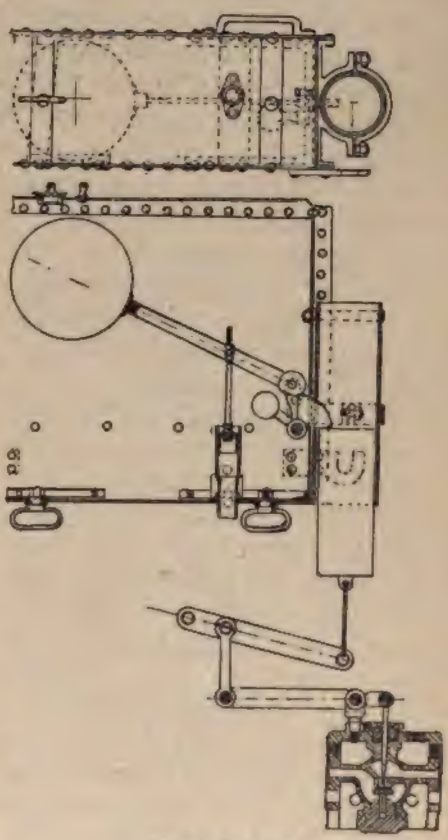


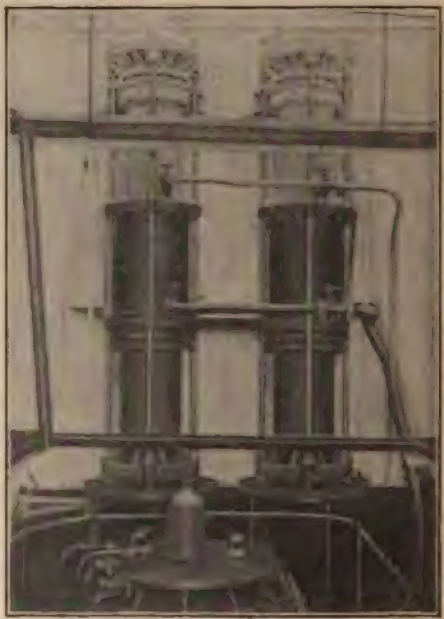
Fig. 1 and Fig. 2.

individually, from the captain's bridge, or any other convenient point. This English system also provides that should this precaution be neglected at the captain's bridge or elsewhere by those in charge, the entrance of water into any one or more compartments would automatically close the bulkhead doors in those compartments. The illustration and drawings show the apparatus as fitted in the imperial mail steamer "Deutschland" of the Hamburg-American line.

It is claimed that the failure of bulkhead doors has arisen in the past in almost every case from the length of time required to effect the closing at the critical moment. In the past the doors have had to be closed mostly by hand and individually. This hydraulic system for closing bulkhead doors which is claimed to render ships unsinkable was installed on the "Deutschland" and the "Kaiser Wilhelm II," as noted in the drawings, Figs. 2 and 4, by J. Stone & Co., of Deptford, London, England.

A warning bell sounds before the door commences to descend, and as the door descends very gradually it can be stopped, raised or lowered by means of a lever placed close to it on both sides of the bulkhead. It will thus be seen that there is no danger of anyone finding himself trapped in a flooded compartment.

The doors are closed at a regulated speed under pressure which is sufficiently powerful to cut through three or four feet of coal; but it is said it is not so dangerous or ineffective as when the allowing the doors to fall by their own weight. The "Deutschland" has twenty-four watertight doors and pressure is supplied to all of the doors by a pressure-main running the whole length of the ship, and this main is in communication with four steam hydraulic accumulators, as shown in Fig. 1. They have a sufficient capacity when fully charged to supply a pressure of six hundred pounds per square inch, to close all of the doors, and even if the pumps should be stopped they are capable of opening and closing a group of eight doors. A duplex long stroke slow speed hydraulic pressure pump has been provided for charging the accumulators and pressure main, the pump being capable of supplying pressure to close all of the doors without the



accumulators in ten seconds.

A five hundred gallon tank has been installed from which the hydraulic pump draws, all of this apparatus being located above the water line. From the pressure main a branch rises

to the bridge, and by means of a distribution box the pressure can be turned into either of the two smaller pilot mains which run the whole length of the ship. One of these pilot mains is used for operating the controlling valve at each door for opening the same and the other for closing it. An hydraulic differential cylinder is arranged at each door of an area sufficient to close the door with a force of one, two or more tons, as desired.

In case of a collision it is possible for the officer in charge on the bridge to sound warning bells throughout the ship by simply moving a lever, which at the same time releases the action which starts the closing of all the bulkhead doors, the latter being effectively closed in a very short time. In case anyone should be shut in a compartment, it is possible to open the door on either side by moving the lever provided for the purpose; and the door closes automatically behind them so that it is impossible for the door to remain open.

In case the officer in charge should fail to close the bulkheads the in-rush of water would close the doors of that compartment automatically, and an automatic indicator shows on the bridge the exact position of every door, so that the officer in charge can always know whether any particular door is closed or open.

The accompanying diagram, Fig. 3, shows the arrangement of a small well near the door arranged with a lever and a hollow brass ball. The ball is raised as the water enters the well, and the lever is moved so that it releases the weight, operating a valve on the hydraulic main, and in this way automatically closing the bulkhead door. The exhaust main runs the whole length of the ship under the floor plates. It exhausts into a 200-gallon tank in the engine room and a small auxiliary pump discharges it into the 500-gallon supply tank above the water line. The auxiliary pump is also available for pumping at high pressure into the hydraulic main. By using three parts of water and one part of glycerine for the pressure fluid freezing is prevented and the consequent bursting of pipes while it also acts as lubricant to the bearing surfaces and a preservative to the packings, leathers and joints.

In the event of an accident to the mechanism of the system, all of the doors close automatically. The hydraulic cylinder drives the door shaft by means of powerful spur gear, bevel wheels being used in connection with a hand gear on the upper platform. The handle with quadrant is duplicated on the other side of the bulkhead and operates the controlling valve on the upper platform by steel wire cords.

At the present time the motive power which might be employed for opening and closing the bulkhead and other doors on ships includes steam, electricity, compressed air and hydraulics. Many engineers hold that steam power should not be employed for closing bulkhead doors on account of the danger of scalding, while others claim that electricity should not be employed on account of damage to wires, interruption of current by melting of fuses and for economical rea-

sons. Those engineers favoring hydraulic methods claim the compressed air pumps are more expensive, while hydraulic power is more reliable, is cheaper, safer and more advantageous than any other which can be used. It is interesting to note an extract from the official Admiralty Minute on the loss of H. M. battleship "Victoria."

"Before the collision took place, a large number of watertight doors, hatches and ports were open and that owing to the inrush of water many of these, situated in the forward part of the ship, could not afterwards be closed. Many compartments must therefore have been flooded in addition to those which were actually breached by the collision."

"The question remains, What would probably have happened if all doors, hatches, etc., had been closed in the 'Victoria' before the collision took place? Investigation shows that while the loss of buoyancy must in the case have been considerable, yet making all due allowance for probable damage, the ship would have remained afloat, and under control, and able to make port under her own steam. Her bow would have been depressed about to water level; her heel to starboard would have been about one-half of that observed before the lurch began; her battery ports would have been several feet above water, and she would have retained ample stability."

It will be noted from the above that a reliable system for closing bulkhead doors had it been in successful operation on the "Victoria," whether operated by steam, electricity, compressed air or hydraulic power, would have saved this English battleship together with her officers and crew. Whether ships may be rendered absolutely unsinkable is a question difficult to determine with certainty, but there is every reason to believe that a reliable system for controlling the doors of the airtight compartments is practically the only method of providing against the sinking of ships in case of collision or other accident where the ship's hull is punctured.

MECHANICAL.

Power Transmission by Belting.

BY CARL H. BEACH.

When power is generated at one point to be used somewhere else at a greater or less distance the question, how may it be transferred with the greatest economy and safety, always arises. Economy of time, money and space and safety to life and property. It would not be wise to attempt the transmission of power over a distance of 500 or 1,000 feet by leather belting which would not only be expensive to install and operate, but would be very bulky. There are, however, instances where wire ropes have been used to transmit power over very long distances, as, for example, cable street railways, which were so common a few years ago. No one method of power transmission will meet the requirements of all cases, and in many, if not most instances, no one method alone will accomplish the desired results so a combination of two or more are employed.

When a fixed speed ratio is not imperative some form of belting is usually most satisfactory. It is flexible, cheap to install and keep in repair when the span is not too great and the belt is not exposed to heat, moisture or oil.

Leather belting is composed of strips of leather riveted, glued or sewed together to form a continuous band of the required length; the width depending upon the amount of power to be transmitted and some other conditions which will be discussed further on.

Belting might be treated mathematically to obtain the amount of power that it can reasonably be expected to transmit, but the formulæ thus obtained are cumbersome and contain such unknowns:

f—the co-efficient of friction which varies from .15 to 1.35;

T_1—the tension on the driving side;

T_2—that on the following side, both of which may vary from little more than the weight of the belt to 1,000 or 1,500 pounds per square inch of belt section.

To obviate the difficulty thus arising it is quite customary to use one or another of the many empirical formulæ, a few of which together with other data are taken from Prof. Kent's Mechanical Engineers' Pocket Book, pages 877 to 887.

Let d=diameter of pulley in inches; rd=circumference; V=velocity of belt in feet per second; v in feet per minute; a=angle of the arc of contact;

L=length of the arc of contact in

feet;

F=tractive force per square inch of sectional area of belt;

w=width of belt in inches;

t=belt thickness;

S=tractive force per inch of width $=\frac{F}{t}$

r. p. m.=revolutions per minute;

r. p. s.=revolutions per second $\times \frac{\text{r. p. m.}}{60}$

The production of 33,000 foot-pounds of work in a minute constitutes a horse-power, hence:

$$HP=\frac{S\ v\ w}{33000}=\frac{S\ V\ w \times 60}{33000}=\frac{S\ V\ w}{550} \quad (a)$$

But as

$$V=\frac{\pi d\ \text{r.p.m.}}{12\times 60}=.004363\ \text{d.r.p.m}=\frac{\text{d. r.p.m.}}{229.2};$$

we obtain by substitution in (a);

H. P.=.000007933 Sdwx r. p. m. (b)

When F=275. and t=7-32, S=60 lb. nearly and formulæ (a) gives

$$HP=\frac{V\ w}{550};$$

$$\text{but } V=\frac{\pi\ d\times \text{r.p.m.}}{12}=.2618\ d\times\text{r.p.m.}$$

which gives upon substitution

$$HP=\frac{w\ d\times \text{r.p.m.}}{2101} \quad (1)$$

Again, if F=180. t=1-6, S=30. ; and we have by substitution as before:

$$HP=\frac{V\ w}{1100}=\frac{w\ d\times\text{r.p.m.}}{4202} \quad (2)$$

A rule often assumed differs slightly from the preceding, and is,

$$HP=\frac{V\ w}{1000}=\frac{wd\times\text{r.p.m.}}{3820}; \quad (3)$$

which corresponds to S=33lb.

Others use S=45 lb.giving

$$HP=\frac{V\ w}{733}=\frac{w\ d\times\text{r.p.m.}}{2800}. \quad (4)$$

Prof. Kent seems to favor the assumption that the transmitting power of double belts is 10-7 that of single belts rather than that it is doubled. The first assumption applied to formulæ (4) gives

$$HP\ (\text{Double belts})=\frac{wd\times\text{r.p.m.}}{1960} \quad (5)$$

which corresponds to S=64.3.

All formulæ given so far assume the arc of contact to be 180°, but should it be otherwise, the results given by the formulæ should be multiplied by n where n is the number $\frac{}{100}$ of degrees of contact.

If the velocity of the belt is more than 3,000 feet per minute the centrifugal force becomes so great that it tends to lift the belt off of the pulley, thus decreasing its tractive power though increasing the belt tension.

Mr. A. F. Nagle gives a formulæ to overcome this defect (transactions A. S. M. E., vol. II, 1881, p. 91, tables published in 1882).

$$HP=C\ V\ t\ w\left\{\frac{S-.0012V^2}{550}\right\};$$

$C=1-10^{00758}fa$; (See table I.)

S=stress per square inch of belt section; otherwise the rotation is the same as before.

The results from Nagle's formulæ are given in tables II and III, and the various values of (c) in table I.

The horse-power of laced belts becomes a maximum 87.41 feet per second, and the riveted belt becomes a maximum at 105.4 per second.

TABLES I. VALUES of C.

DEGREES of CONTACT = A.

f	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	200°
.15	.210	.230	.250	.270	.288	.307	.325	.342	.359	.376	.408
.20	.270	.295	.319	.342	.364	.386	.408	.428	.448	.467	.503
.25	.325	.354	.381	.407	.432	.457	.480	.503	.524	.544	.582
.30	.376	.408	.438	.467	.494	.520	.544	.567	.590	.610	.649
.35	.423	.457	.489	.520	.548	.575	.600	.624	.646	.667	.705
.40	.467	.502	.536	.567	.597	.624	.649	.673	.695	.715	.753
.45	.507	.544	.579	.610	.640	.667	.692	.715	.737	.757	.792
.55	.517	.617	.652	.684	.713	.739	.763	.785	.805	.822	.853
.60	.610	.649	.684	.715	.744	.769	.792	.813	.832	.848	.877
.100	.792	.825	.853	.877	.897	'913	.927	.937	.947	.956	.969

Table III. Horsepower of Leather Belts one inch wide,

RIVETED BELTS, S=400

Thicknes in inches =t.

V	7/32 .219	1/4 .250	5/16 .312	7/32 .333	3/8 .375	7/16 .437	1/2 .500
15	1.69	1.94	2.42	2.58	2.91	3.39	3.87
20	2.24	2.57	3.21	3.42	3.85	4.49	5.13
25	2.79	3.19	3.98	4.25	4.78	5.57	6.37
30	3.31	3.79	4.74	5.05	5.67	6.62	7.58
35	3.82	4.37	5.46	5.83	6.56	7.65	8.75
40	4.33	4.95	6.19	6.60	7.42	8.66	9.90
45	4.85	5.49	6.86	7.32	8.43	9.70	10.98
50	5.26	6.01	7.57	8.02	9.02	10.52	12.03
55	5.68	6.50	8.12	8.66	9.74	11.36	13.00
60	6.09	6.96	8.70	9.28	10.43	12.17	13.91
65	6.45	7.37	9.22	9.83	11.06	12.90	14.75
70	6.78	7.75	9.69	10.33	11.62	13.56	15.50
75	7.09	8.11	10.13	10.84	12.16	14.18	16.21
80	7.36	8.41	10.51	11.21	12.61	14.71	16.81
85	7.58	8.66	10.82	11.55	13.00	15.16	17.32
90	7.74	8.85	11.06	11.80	13.27	15.48	17.69
1.00	7.96	9.10	11.37	12.13	13.65	15.92	18.20

Table II. Horsepower of Leather Belts one inch wide.

LACED BELTS, S=275.

Thickness in inches=t.

V	1/7 .143	1/6 .167	3/16 .187	7/32 .219	1/4 .250	5/16 .312	1/3 .333
10	.51	.59	.63	.73	.84	1.05	1.18
15	.75	.88	1.00	1.16	1.32	1.66	1.77
20	1.00	1.17	1.32	1.54	1.75	2.19	2.34
25	1.23	1.43	1.61	1.88	2.16	2.69	2.86
30	1.47	1.72	1.93	2.25	2.58	3.22	3.44
35	1.69	1.97	2.22	2.59	2.96	3.70	3.95
40	1.90	2.22	2.49	2.90	3.32	4·15	4.44
45	2.09	2.45	2.75	3.21	3.67	4.58	4.89
50	2.27	2.65	2.98	3.48	3.98	4.97	5.30
55	2.44	2.84	3.19	3.72	4.26	5.32	5.69
60	2.58	3.01	3.38	3.95	4.51	5.65	6.02
65	2.71	3.16	3.55	4.14	4.74	5.92	6.32
70	2.81	3.27	3.68	4.29	4.91	6.14	6.54
75	2.89	3.37	3.79	4.42	5.05	6.31	6.73
80	2.94	3.43	3.86	4.50	5.15	6.44	6.86
85	2.97	3.47	3.90	4.55	5.20	6.50	6.93
90	2.97	3.47	3.90	4.55	5 20	6.50	6.93

In tables II and III the angle (a) is 180°, but should it be multiply by

90°	100°	110°	120°	130°	140°	150°
.65	.70	.75	.79	.83	.87	.91
160°	170°	180°	200°			
.94	.97	1.00	1.05			

The problem usually presenting itself for solution is usually not to find the horse-power that a given belt will transmit, but to find a belt to transmit a given horse-power under some fixed conditions. This is easily found from any of the preceding formulæ by solving for (w), of course having due regard to the conditions under which the belt is to operate when selecting the particular formulæ to be used. A series of tables like those above, made to include some of the most common conditions of co-efficient of friction and stress per square inch of belt would be of great assistance in making the computations, as the width would then be:

$$W = \frac{H.\ P,}{p.}$$

H. P.=Horse-power to be transmitted.

p=Power per inch as taken from the proper table.

In erecting machinery the easiest way to find the length of belt for two given pulleys is to run a tape around them and deduct an inch for every ten feet of length to allow for stretch. This, however, is not possible for the designer, but he may find the approximate length by the following:

$L=(R+r)3\frac{1}{4}+2l$;

R=Radius of large pulley;

r=Radius of small pulley;

L=Length of belt;

l=Distance between centers;

a=Angle whose sine is $R-r\div l$.

The angle of contact with the smaller pulley is:

$$180°-2a;$$

and with the large pulley:

$$180°+2a.$$

The best speed at which to run a belt is about 4,000 or 4,500 feet per minute.

The working tension is not usually more than 500 pounds per square inch, or about 1-3 the ultimate strength of the joint, and averages about 275 pounds per square inch.

The Jamb Nut.

TO aid in the staying power of a nut on a bolt or stud the screw is made longer and a second nut put on and turned down tight upon the first.

Some designers are inclined to make this "jamb" nut thinner than the holding nut and to place it as in Fig. 1. It is found that in screwing down the top nut that the bolt is practically lifted out of the lower one and the top one carries the strain so that the nuts had better be arranged as in Fig. 2.

To make a neat appearance, the top nut should be chamfered, and since

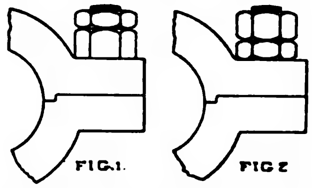
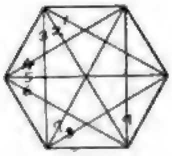


FIG. 1. FIG. 2

jamb nuts are easily obtained in this style the top one should be made the same.

Diagonals of a Polygon.

The nnmbers of diagonals that may be drawn in a polygon bear some relation to the number of sides. From the illustration it will be seen that



nine can be drawn in a polygon of six sides and we can see that in one of four sides only two.

In an right sided polygon we have twenty seperate diagonals so it seems that the number does not stand any definite relation to the number of sides but from Geometry we find that the number of diagonals is

$$\frac{m(n-3)}{2}$$

where n is the number of sides.

Then in the case of six sides we have

$$\frac{6(6-3)}{2}=9 \text{ as shown.}$$

Origin of the Oldsmobile.

IN 1887 Ransom E. Olds made the first practical gasoline automobile runabout known. This first wagon, which was a practical, though not altogether graceful machine, was made possible by the Olds gasoline motor, invented by Mr. Olds in 1885. The idea of applying this motor to mechanical traction began to grow in the inventor's mind, and two years later the first "Oldsmobile" made its appearance. It was a tri-cycle with wooden wheels and steel tires and weighed about 1,300 pounds. It was equipped with a single-cylinder motor, 3 inch bore by 6 inch stroke, hot tube ignition. The gear was a variable ratchet transmission. This was the first vehicle made to run by means of a gasoline motor in America.

With this machine as a basis for experiment, the work of improvement was pushed slowly but carefully, until in 1892 the second Olds wagon made its appearance on the road. This vehicle was a step forward, having four wheels of wood, with steel tires. The 42-inch driving wheels were placed in front and the 24-inch steering wheels behind. It was driven by a pair of cylinders 3 inch bore by 8 inch stroke, hot tube ignition. The transmission was a simple spur pinion and gear, three to one reduction, direct from the motor-shaft to the balance gear on the rear axle, with no reverse movement. This wagon was sold in 1892 to a London firm for $400. It was shipped to Bombay, and has never been heard from since.

In 1894 the third Olds motor wagon was started. It was the first to be equipped with tires. These were of solid round rubber, 1½ inches in diameter, on all four wheels. The wheel base of this new wagon was 54 inches, the rear wheels 36 inches in diameter, the front wheels 34 inches. The rear wheels were driven by three separate chains from sprockets on the motor-shaft to the rear axle, the rear axle sprockets having spring cushions interposed. The gear was three speeds ahead and a reverse by an intermediate spur pinion. The motor was a water-cooled, single-cylinder, 4½ inch bore by 8 inch stroke.

Arrangements were made to enter this wagon in the Chicago *Times-Herald* competition in 1895, but it was not ready in time, and consequently did not make its appearance. When perfected, however, this wagon proved so satisfactory that the possibilities for its success as a commercial venture were quite evident. Three wagons of this type were made, and one of them was sold for $900. One of them was used continuously by Mr. Olds up to the time of the organization of the Olds Motor Vehicle Company in 1897, with a capital stock of $50,000.

This company was superseded in 1899 by the present company. In the neighborhood of $80,000 was spent in producing expensive models of different types, most of which were really fine vehicles. Some, however, were too expensive, and all were open to one objection or another, which made them impractical for a wide market. Guided by all this costly experimenting, the company began anew, having by this time a definite object in view,

viz., the production of a runabout to weigh about 500 pounds and to sell as near to $500 as cost would permit. This called for the utmost simplicity of design and detail. In October, 1900, the new machine was produced and placed on the road for a trial. With the exception of the springs it was the Oldsmobile of the present day.—"*The Automobile.*"

Drawing Dimensions.

A lever arm was to be made of cast iron, and a drawing was made for the pattern shop illustrated by Fig. 1.

Shortly after the drawing was made it was decided to make a forging instead of a casting.

It was first thought that the same drawing prepared for the pattern shop could be given to the blacksmith.

While there is no doubt that an intelligent blacksmith could have made the lever arm from this drawing, but not without mental arithmetic.

As will be seen the dimensions as given are based on center lines which are preferred by patternmakers.

A blacksmith's work is most generally in the rough stage, and to work from center lines is impractical in many cases, this being one.

Therefore the dimensions were revised as illustrated by Fig. 2.

A. E. EISERER.

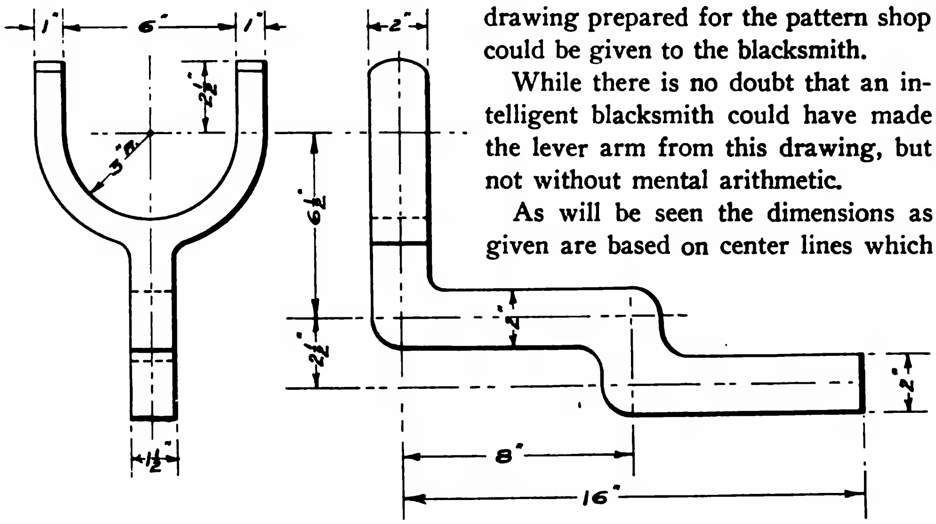


FIG. 1.

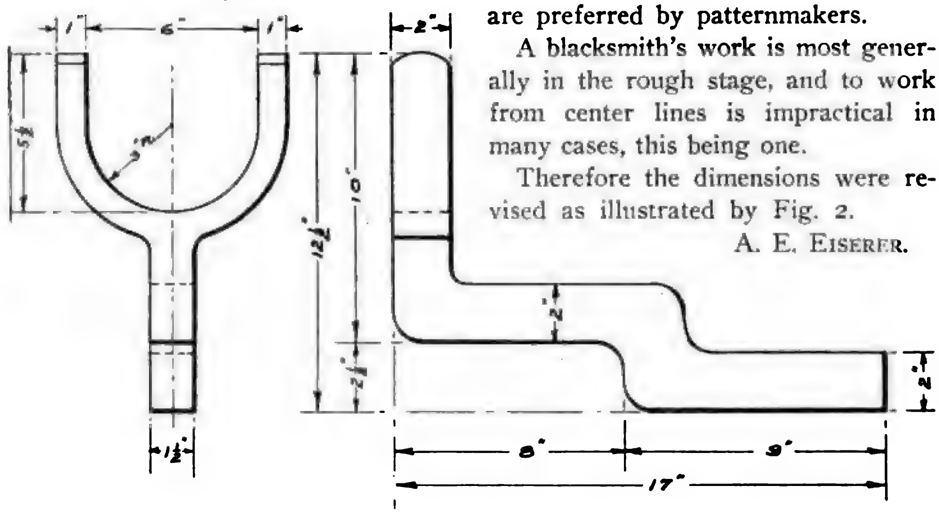


FIG. 2.

Change Gears.

The question of the change gears for lathes and the amount of time and inventive genius that has been devoted to the matter in the last few years would seem to render the subject one of considerable interest to the men who design lathes, the manufacturers, the buyers, and the men interested in the obtaining of patents upon the various devices.

Mr. Oscar E. Perrigo, of New Haven, Conn., has devoted much time and study to the subject, and the results of his investigation, which included the examination of 164 patents, has been put up in book form.

In "Change Gears" there are 29 of above list of patents considered and described, and their special features illustrated and compared in a way that will prove both instructive and useful to those interested in this line of mechanical work. It is printed on coated book paper, well bound, 5¼ x 7¾ in. pages. Price, $1.00. The Derry-Collard Co., Publishers, 257 Broadway, New York.

"Threads and Thread Cutting," being No. 4 of a series of practical papers published by The Derry-Collard Co., 256 Broadway, New York. Price, 25c.

It is a simple explanation of the mysteries of screw cutting by the various means used in the shop, and well worth considering when information is desired on the above subject.

Spiral Springs.

The effective number of coils is generally two less than apparent number, owing to flattening of ends. The stroke of a spiral spring is the effective number of coils $\times$ compression or extension of each coil. Diameter of coil should be about 8 times diameter of steel.

Where E=compression or extension of one coil in inches, D=diameter of coil in inches from center to center, d=diameter of round, or side of square steel in 1-16 of an inch W=weight applied in lbs., c=an experimental constant taken as 22 for round steel and 30 for square steel

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Work is progressing rapidly on Brazil's pavilion at the World's Fair. It will be one of the largest and finest foreign government buildings. It will cost $130,000.

Alloy or Bearings.

A formulæ used on the Pennsylvania Railroad in making the standard bearings is as follows:

	Lbs.
Copper	105
Phosphor bronze, new or scrap	60
Tin	9¾
Lead	25¼

CRUEL PUNISHMENT.

A man who was caught in the act of committing burglary at Paterson, N. J., was ducked several times in clean water and then told to leave town. It is reported that the friction he created in the air as he left almost set his clothes on fire.

There are abundant supplies of coal in Japan, not only in the northern island, but also in the southern parts of the empire.

ARCHITECTURAL.

Architectural Engineering.

BY SEWALD CHARLES.

IT may be said that structural engineering is the study of the skeleton of a building and treats only of the proper proportioning of the members, the stability of the structure, without regard to the ornamentation.

It is the purpose in this issue to merely state the definitions and terms in the simplest language possible, and these should be understood before going any further.

Mechanics is that branch of science which treats of the forces and effects upon bodies.

Force is that which tends to destroy or create motion.

Rest is that state in which a body lies when not acted upon by external forces.

Motion is the opposite of Rest.

Equilibrium is that state in which the forces are acting in the opposite directions and with the same intensity.

All draftsmen and designers should be familiar with Newton's Laws of Motion, as it is by these laws that all principles of mechanics are carried out. As the principles of mechanics are used for determining the reactions it is essential that they should be thoroughly understood before attempting any steel designing.

Now let us consider a beam about 20 feet long, supported at both ends, and having a uniform load of 500 lbs. per foot, and a concentrated load of 1,000 lbs. at the center.

We know from experience that the beam will bend to a certain extent, and in doing so the fibers in the upper half tend to push together or compress, this is *compressive stress;* those below the center line or neutral axis tend to stretch, this is *tensile stress.* At the points of the support there is another stress, *shearing stress*, caused by the beam tending to shear or slip down between the supports.

The dividing line between the tensile and compressive stresses is known as the *neutral line* and lies in the *neutral plane*, and this lies in the *center of gravity* of the beam. The center of gravity of a body is the point from which, if the body be suspended, it would be in equilibrium.

Now, again referring to the same beam, we notice there is a certain *deflection* which is in proportion to the load and the manner in which it is loaded. Should the load be removed the beam wlll tend to assume its natural shape, if the *elastic limit* has not been exceeded, and if it has and the beam does not return to its original shape upon the removal of the load, it is then said to have taken a *permanent set*. Consequently the elastic limit is the stress just great enough to produce the least permanent. It is

usual in practice to try beams for deflection when they are to support very great loads, as this is of very great importance.

Suppose upon the removal of the load it is found that the beam in question had *stretched* or *elongated* and that it does not return to its original shape or length, then it is said to be strained beyond the elastic limit. This is called the *modulus of elasticity* and is the ratio of unit stress to the unit strain for loads within the elastic limit.

When a body is stretched or shortened it is said to have been subjected to a *strain* and the unit strain is the strain per unit of length.

$$S = \frac{E}{L}$$

S=unit strain.

L=length in inches of the body.

E=elongation in inches.

The *intensity of stress* is the stress per unit of area and may be found by the following:

S=unit stress per sq. in. in pounds.

P=Total stress in pounds.

A=Area of section in inches.

$$S = \frac{P}{A}$$

The *ultimate strength* of a piece of timber or member of a frame is that strength which is just sufficient to SIX — Draftsman O'donnell 17 break it. In building it is not practical to allow a beam or column to carry its full load, because unforeseen loads may be imposed upon the structure which have not been allowed for, hence, a *factor of safety* is used, and is the ratio of the ultimate strength to the load it is required to carry. This number varies with the kind of material and the precautions to be taken. Usually the following are used: Steel, 3 to 4; Wood, 4 to 5; Cast Iron, 5 to 10; Stone, from 10 up, according to quality. A column required to support 100,000 pounds will not break until 300,000 pounds is imposed upon it if the factor of safety is 3.

The *modulus of rupture* is a constant used for determining the strength of beams, and varies as the strength of the material, as in steel 60,000 and 2,000 in stone of coarse texture.

The *moment of inertia* is another expression used to a very great extent in steel work, and depends upon the distribution of the body or on the surface with respect to a given axis. The formulæ for obtaining the same is as follows:

$$I^1 = I + ar^2$$

I=moment of Inertia sought.

I=moment of Inertia with respect to a given axis (found in tables of rolled sections).

a=area of figures.

r=distance from center of gravity to axis required.

The foregoing is often used in connection with another, the *radius of gyration,* and is equal to the square root of the moment of inertia divided by the area.

$$R = \frac{I}{A}$$

R=radius of gyration.

I=moment of inertia.

A=area of figure.

This is often made to read, ———— in which form it usually appears in the column and other formulæ.

Next issue Reactions and I Beams.

Organization of Twin City Architectural Club.

STEPS have been taken by the architectural draughtsmen of the Twin Cities to perfect an organization. Preliminary action was taken a few days ago and the organization will be perfected within the next two weeks. The association is to be known as the Twin City Architectural Club, and is to be for the study of architecture, and all matters pertaining to the allied arts and crafts.

The organization is to admit as active members only the architectural draughtsmen of the Twin Cities. The architects of the two cities have been invited to join as honorary members and the members of the different crafts employed on the finer parts of a building and known in architectural parlance as "material men" have been asked to come in as associate members.

The object of the organization is to promote and advance the science of draughting. It is claimed that the ordinary draughtsman working under an architect has little chance to show any originality and artistic talent that he may have. His work, it is maintained, is done according to the ideas and plans of another.

ANNUAL COMPETITION.

In order that each member may have to show and develop talent, the club will hold four competitions a year. The subjects and the rules to govern the contest will be arranged by a committee.

There will be three architects selected to act as governing board, who will pronounce on the merit of the sketches submitted. There have been draughtsmen's clubs in St. Paul and Minneapolis for sketching, but it was found that not enough members of the craft in one city alone could be secured to carry such an organization through successfully, so it was decided to have the two cities join.

The club will, from time to time, ask prominent architects to address the members on topics of interest to them. Engineers and other persons engaged in the construction of buildings will also be asked to address the club on subjects concerning the actual construction of a building.

SKETCHING TOURS.

The club will go on sketching tours throughout the two cities and State in the summer. Factories, mills and foundries will be visited and sketches made. Buildings in process of construction will be inspected and sketches made. These trips are designed to give the average architectural draughtsman a practical as well as theoretical knowledge of the construction of a building.

The next meeting of the club will be held in Minneapolis, February 19, when some one will be selected to lecture to the club on "Stained Glass," the lecture to be illustrated by lantern slides.

The following officers have been selected: President, Hal Eads; first vice president, George H. Blewitt, St. Paul; second vice president, Albert Van Dyke, Minneapolis; secretary, C. B. Chapman, Minneapolis; treasurer, John H. Wheeler, St. Paul; executive committee, F. G. Corser, Minneapolis, and Thomas A. Cresswell, St. Paul.

STRUCTURAL.

Structural Engineering.

As an I beam is very commonly used for structural purpose, it is quite essential we should be able to determine the proper size under certain given conditions.

The reactions being determined by the laws of the lever, it is necessary to understand their principles.

Figure I shows a simple lever which is in equilibrium and in which the greater distance from the fulcrum to point of application of load, and l the lesser distance from fulcrum to the point of application of the load.

A *moment* is the length through some given axis, as in the lever; the fulcrum, multiplied by the weight and expressed in inch-pounds foot-pounds or ton-pounds, depending upon the unit of length decided upon. In the case of I beams it is best to use inch-pounds.

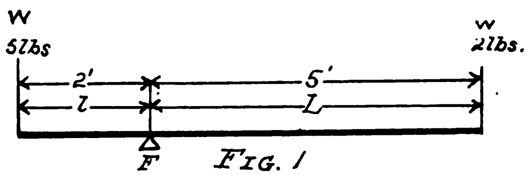


FIG. 1

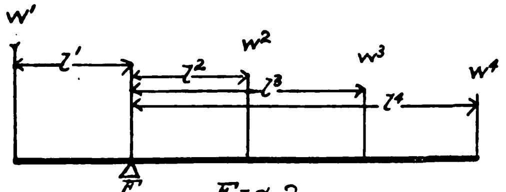


FIG. 2.

case, as in all other cases, the force on one side multiplied by the length of the power arm is equal to the force on the other side multiplied by the length of the weight arm, hence the moments are equal and

$$Lw=Wl.$$

In this equation W equals the larger weight w, the smaller weight L

Suppose we consider a lever loaded Insert Fig. II.

The moments respect to the fulcrum F are

$$l_1w_1=l_2w_2+l_3w_3+l_4w_4,$$

and when so loaded both sides must balance.

Now as applied to a beam, which may be any one of the following: a

fixed beam, or one in which both ends are securely held, a cantilever beam, or one in which one or both ends overhang the support, a continuous beam, or one which rests upon two or more supports, or a simple beam, or one supported at both ends, the last named being the one herein considered.

When a beam is supported at both ends there must be an upward pressure at the supports in order to balance the forces acting in a downward direction, and these upward forces are called *reactions*. In all cases the sum of the loads upon a beam must equal the reactions, and in any beam uniformly loaded the reaction at each support is equal to one-half of the load.

Throughout the entire beam there is a tendency of the fibers to shear or cut; this is greatest at the point of supports and decreases toward the center. Supose we call the shear at the right reaction or support positive and that at the left negative; then it follows there is some point between at which the shear is zero; this is called *the point at which the shear sign changes*. The shear at any point on a beam may be found by subtracting from the reactions, each succeeding load to the point considered. This is very necessary to know, as when a beam is not symmetrically loaded the point of change of shear sign must be found before the bending moment can be found, and the size of the beam determined. This will be more fully treated in a later issue.

In all beams there is more or less tendency to bend, and if the beam is uniformly loaded is greatest at the center of the beam, and if not so loaded the greatest bending moment is under the greatest load. The bending moment at the supports is zero, and increases as the tendency to shear decreases. In determining the size of I beams they are generally tested for bending stresses only. In the table given the different methods of loading are given.

Now let us consider the following problem: An I beam is to span an opening of 30 feet and carries a load of 500 pounds per running foot. Allow 3 for a safety factor and 60,000 pounds for modulus of rupture of steel. Determine the size of the beam.

As the beam is uniformly loaded, each reaction will equal one-half the load, or 7,500 foot-pounds, or the two will equal 15,000 foot-pounds.

By formulæ I

Bending moment=W (weight of load) $\times$L (length of span).

This equals 56,250 foot-pounds, or, multiplying by 12, 675,000 inch-pounds. Using a factor of safety 3 and the modulus of rupture of steel being 60,000 pounds, 60,000=20,000 pounds.

Then 675,000=33.75, or the section modulus of the beam required.

Now, looking down the table under the head of "Section Modulus," we find that a 12-inch beam weighing 30.6 pounds per foot has a modulus of section of 34.66, hence this is the nearest to the size and being on the safe side should be used.

The deflection may be determined by applying the formulæ opposite the manner of loading, and using the

Standard I Beam.

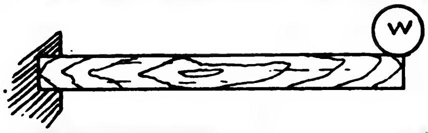
Depth of Beam.	Weight per Foot.	Area of Section in Inches.	Moment of Inertia on Axis x—y	Section Modulus on Axis x—y
4	6.3	1.80	5.01	2.52
4	7 4	2.16	5.83	2.90
5	0.3	2.76	11.57	4.65
5	12.4	3.60	13.35	5.35
6	11.9	3.50	21.13	7.05
6	32.2	9.49	52.52	17.50
6	46.1	13.56	68.56	22.85
7	14.6	4.31	35.42	10.12
7	17.9	5.29	39.43	11.26
8	17.3	5.13	54.30	13.57
8	21.2	6.24	60.27	15.07
9	20.5	6.04	80.78	17.95
9	20.4	7.47	90.50	20.11
10	23.5	6.91	112.42	22.47
10	30.3	8.91	129.08	25.83
10	34.9	10.29	153.94	30.80
12	30.6	9.01	207.91	34.66
12	39.4	11.60	268.31	44.72
12	55.6	13.62	362.89	60.47
12	66.9	19.67	403.39	67.24
15	41.2	12.12	433.01	57.73
15	52.9	15.57	497.67	66.37
15	56.9	16.75	560.78	74.78
15	69.2	20.39	709.89	94.68
15	85.1	25.02	789.25	105.23
20	64.9	19.04	1145.8	114.59
20	78.2	22.95	1367.36	136.75
20	98.3	28.95	1567.39	156.75

moment of inertia given in the table. Allow 29,000,000 for the value of E, the modulus of elasticity.

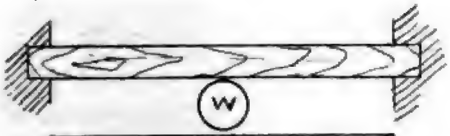
In determining the size of I beams the following course should be pursued: Determine the reactions if not uniformly loaded; if it is, find bending moment by proper formulæ and reduce to inch-pounds by multiplying by 12. Then divide the modulus of rupture of steel, usually taken at 60,000 pounds, by the factor of safety. Divide the bending moment by the last result, and this result will be the section modulus of the beam required. Looking in the table under "Modulus of Section" may be found a number equal to or near the one obtained. At the left of the table will be the size of the beam to use.

Bending Moment in Foot pounds. — Deflection

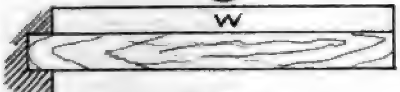
$\frac{W\,L}{8}$ — $\frac{5\,W\,l^3}{384\ EI.}$



$W\,L$ — $\frac{W\,l^3}{3\ EI.}$



$\frac{W\,L}{4}$ — $\frac{W\,l^3}{48\ EI.}$



$\frac{W\,L}{2}$ — $\frac{W\,l^3}{8\ E\ I}$

$\frac{W\,L}{6}$ — $\frac{W\,l^3}{60\ EI.}$

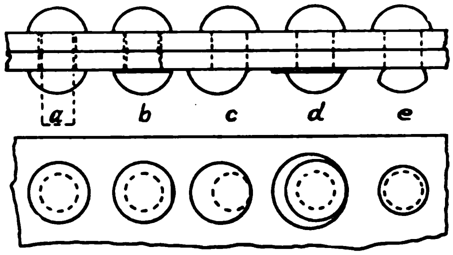
Note : l=length of span in inches.

Rivets in Steel Work.

C. J. TILDEN.

IN dealing with the question of rivets in structural steel work the writer does not pretend, in what follows, to make anything like an exhaustive investigation of the subject. The intention is merely to note briefly some of the differences between theoretical and actual conditions, which have been noticed in an experience of some years in shop and drafting-room, and to suggest, if possible, a means of comparison, in this particular instance, between theory and practice.

A theoretically perfect rivet should fill the hole completely, be of homogeneous material throughout and have two well-formed heads. The strength of a riveted joint depends, theoretically, on but two considerations: first, the shearing strength of the rivet material, usually soft steel; and, second, the number of rivets used. When comparatively thin plates are joined by rivets of large diameter, it may happen that the resistance of the metal to crushing is less than the shearing strength of one rivet; in which case the crushing or "bearing" value of the metal determines the value to be given to each rivet in calculating the strength of the joint. The question then arises, with what degree of safety may the designing engineer accept these theoretical assumptions, and how are they borne out by the conditions which occur in shop practice?



In the first place, the material of a rivet is not homogeneous. In a large majority of cases it is probable that test pieces taken from different parts of a rivet after driving, assuming that such small pieces could be properly tested, would show widely different characteristics, and these totally different from similar tests of the same rivet before driving. A very good idea of the great difference in quality of rivet material after driving may be gained by watching for a few hours a shop gang engaged in cutting out rivets which have been condemned by the inspector. Sometimes the metal is hard, tough and fibrous; then again nearly as soft, to all appearances, as lead or pewter; and occasionally the rivet head will fly off at the first blow of the hammer, apparently almost as hard and brittle as glass.

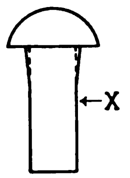
A second noteworthy discrepancy in the design of riveted joints is the

failure to take account of the action of the rivet heads in bringing the two or more surfaces into very close contact, so that a large amount of friction is developed. It is quite possible that this friction may amount to more than the shearing strength of the rivet. In any event, it is a very important factor in the strength of a riveted joint.

In the diagram, Fig. 1, are shown some of the more frequent imperfections in rivet work, resulting from carelessness of the workmen. At *a*, for comparison, is sketched a perfectly driven rivet. The original form is shown dotted, the "shank" being 1-16 or 3-32 of an inch less in diameter than the hole which it is to fill, and enough longer than the "grip," or length between heads, to allow the formation of the new head, and the squeezing out of the rivet material sufficiently to fill the hole completely. Both heads should be concentric with the shank, and the rivet should be perfectly tight, giving a clear sharp ring when struck with a light hammer.

At *b* is shown a loose rivet which has been "caulked" with a cold-chisel, to make it appear tight under the inspector's hammer—a favorite trick of careless riveting gangs, and often very difficult to detect; if suspected, a close examination should be made of the head of the rivet for signs of the caulking tool, especially if the rivet has been generously bespattered with fresh paint or tobacco juice. Both these commodities, always plentiful in the shop, are favorite means of concealment for "scamped" work of this character. A result very similar to caulking, but much harder to discover, is sometimes secured by using the riveting machine, or "bull," as it is familiarly known to the shop men, on the cold rivet. The movable cup of the "bull" is brought sharply against the rivet head, securing somewhat the effect of a blow, and this is repeated four or five times on each loose rivet. In general, this machine caulking is not very effective, but the writer has known instances where it has been successful. It is well-nigh impossible to tell from the appearance of the rivet head afterward if this trick has been attempted. A very slight polish on the head of the rivet is about all the evidence that ever appears, and this is readily hidden by a dab of grease or dirt, or the ever-ready tobacco juice. It is a form of "scamping" that is seldom resorted to, however, as it is more work than caulking with the cold-chisel, and far less likely to accomplish its purpose.

The sketch *b* also shows the probable result of heating the rivet unevenly. When the heating is done in an ordinary portable forge, fired with coke, the forge-tender gets into the habit of heating



only that part of the rivet which is to be upset to form the head, leaving the remainder comparatively cool. Referring to Fig. 2, for example, from the lower end of the rivet to, perhaps, the

point x, the metal is at white heat; above that it cools rapidly until the head is practically "cold," often not even a dull red color. This uneven heating not only prevents the rivet from upsetting throughout its length, and so filling the hole, but is apt to injure the quality of the metal above the point x, owing to its being worked under the hammer at too low a temperature.

Careless manipulation of the riveting-machine may result in the condition shown at *c*, where the head is not concentric with the shank. The fault can be detected only by comparison with the other rivets in the joint, showing uneven spacing and irregular lines.

The condition shown at *d* results from too much metal in the shank of the rivet before driving, giving a "soldier-cap" head. The reverse of this is shown at *e*.

It must not be supposed that these defects are the only ones which occur in rivet work; they are only a few of the more frequent errors of this kind that may be observed in any shop. Combinations of two or more of the forms shown occur not infrequently, and an almost endless variety of changes may be rung on each one. Of the four types, *b* and *e* should be condemned unquestioningly whenever found, being not only bad workmanship, but unreliable. *c* and *d* probably develop the full strength of the rivet, and may be allowed to pass if strength is the only consideration; but if the work is to be exposed they should be cut out and replaced, as they are sure to look ragged in finished work.

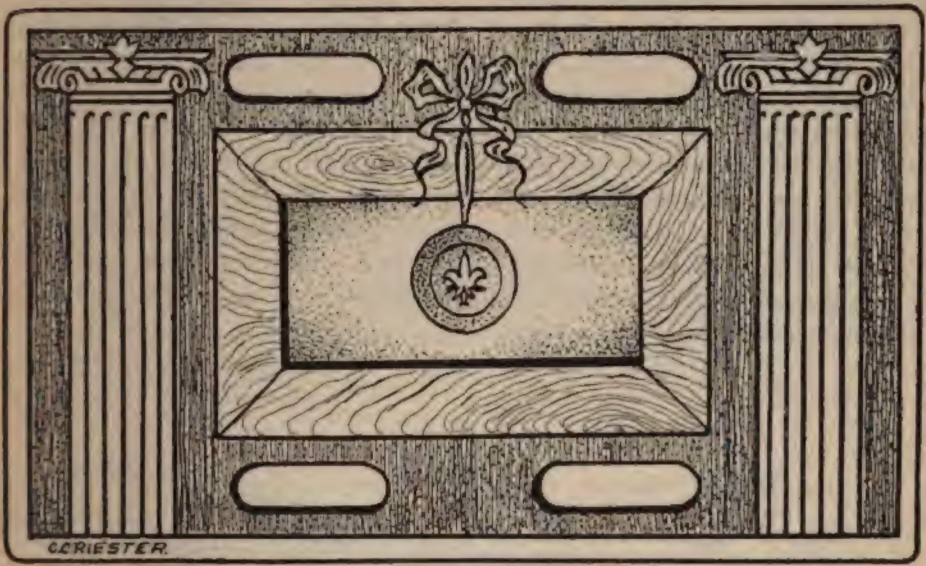
As to the actual difference in strength between a perfect rivet, as *a*, and any of the imperfect ones, it is impossible to judge with any degree of accuracy. In fact, if a test were made it is quite conceivable that a rivet such as *b*, or even *e*, might develop greater strength than *a*. About all that can be said is that this is not likely to happen, but rather the reverse, as a properly driven rivet is more likely to develop its full strength than one which is imperfect in any way. But this is not reducing the question to any scientific basis, and, indeed, it cannot be so reduced. Rigid specifications are required for riveted work, and the work in the shop is subjected to the most careful inspection, not because a carelessly driven rivet is less strong, by any definitely calculable percentage, than one which is properly driven, for the simple reason that careful and accurate work is more reliable.

Figure 2 shows a form of rivet which has certain advantages and disadvantages over the ordinary shape. In this form the shank is slightly increased in diameter (exaggerated in the drawing) for a distance of ½ to ¾ of an inch from the head. Directly under the head, at the base of the cone-like enlargement, the shank has the same diameter as the hole into which the rivet is to go—that is, from 1-16 to 3-32 of an inch larger than the main part of the shank. This is an advantage in the shop, where the rivet is sure to be uniformly heated throughout its length, as it insures the complete filling of the hole up to

the rivet head. In the field, however, where the rivets are likely to be unevenly heated, such a design would be of doubtful advantage. A rivet of this shape might easily appear sound and tight under the inspector's hammer, and yet have been very imperfectly driven.

Structural engineering especially has advanced so rapidly that its followers have had little or no time to devote to its purely experimental phases. It would seem as if a great deal of such work could be put into the technical schools, with much profit alike to the student and to the profession he seeks to enter.—*Extract from paper in Harvard Engineering Journal in Ryerson's Monthly.*

A Neat Panel Design.



Panama Canal Diggers Scale.

While the United States Senate is pondering over the diplomatic features of the interoceanic water way, the dredgemen and cranemen meeting in Chicago have decided what they would charge to throw aside the rocks and sands that separate the Atlantic from the Pacific. The scale adopted by the International Brotherhood of Steam Shovel and Dredge Engineers and Cranemen of America is to be paid in gold. Secondly, they demand free board. These two items disposed of, they raise the rate $50 a month for work in Panama.

The following is the scale adopted:

Panama Canal (per month), engineers, $300; cranemen, $250; Cuba and Mexico (per month), engineers, $160; cranemen, $125; United States and Canada (per month), engineers, $125; cranemen, $90.

HOME STUDY.

Elements of Descriptive Geometry

Descriptive geometry is that branch of science which deals with the methods of representing by drawings of all geometrical magnitudes or objects, and the solution of problems relating to these objects in space.

The idea in these drawings is to make them present to the eye, situated at a particular point, the same appearance as would the object itself, were it placed in the proper position.

These representations or drawings are the projections of the object and are generally made on plane surfaces (or simply planes) called the planes of projection, although they may be made on any surface, cylinder, sphere, dome, etc.

The point at which the eye is situated is called the Point of Sight. There are two general positions for the point of sight: one at an infinite (unmeasurable) distance and the other at a finite (measurable) distance. Let us see how these two general positions of the eye would affect the projections of an object on a vertical plane (V). We will take the straight line A for the object, and let (a) and (b) be points at the extremities of the line. (V) represents a plane perpendicular to the plane of this paper.

O, O′ and O″ are different positions of the eye, or Points of Sight. We see that for the finite positions O and O′ the projections of the object on (V) are larger than the object itself, and that the size of the projection varies inversely as the distance of the Point of Sight from the vertical plane. As this distance approaches infinitely the lines or rays of projection through points (a) and (b) be-

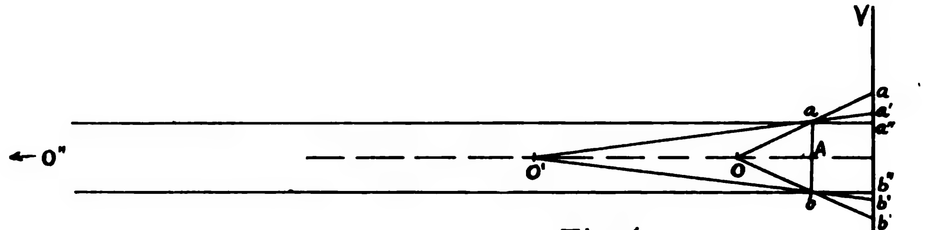
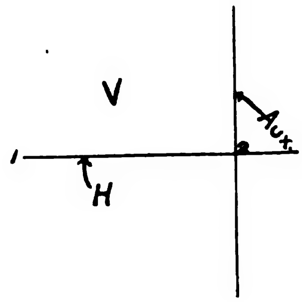


Fig. 1.



lines remain parallel to each other. In the case of O' at infinity they are parallel and the rays of projection are all drawn perpendicular to the plane of projection," making the projection of A on the vertical plane the same

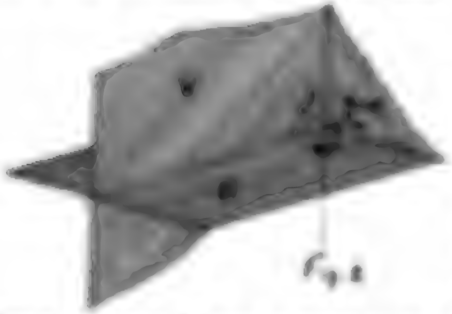


Fig. 2

size as A itself, A being parallel to the vertical plane. In case A were not parallel to the vertical plane given we would have to determine a new plane parallel to A or swing A about a point in itself until it should be parallel to the given vertical plane before we could determine its true length. The process will be explained later under Orthographic Projections.

tal.

Scenographic projections find their applications in illustrating and architecture and in making sketches of the completed machine or other object, to accompany the working drawings.

For the present we will deal with Orthographic Projection only, and perhaps it would be well to state here the connection between Orthographic Projection and Mechanical Drawing. Mechanical Drawing is but a special case of the former in which it is customary to consider all objects as being in the first dihedral angle (explained later), and supplementary planes are taken at right angles to the horizontal (H) and vertical (V) planes of projection. (Fig. 4.)

Orthographic Projection.

Point of Sight is at infinity. Projecting lines or rays are all parallel to each other. The two planes of projection, horizontal (H) and vertical (V) are at right angles to each other and intersect in a straight line called

Fig. 3

We have in the case of O' orthographic projection, and in the cases I and II scenographic projection.

Orthographic projections are used in making working drawings of objects and their parts with the view of giving mathematical conceptions of de-

the ground line. These two planes divide space into four dihedral angles, as shown by Fig. 3. Objects taken in any one of the four dihedral angles. Supplementary planes taken in any direction or at any angle with planes of projection.

In endeavoring to represent these diedral angles on a plane surface such as drawing paper, it is necessary to imagine one of the planes of projection together with the projected points in it revolved into the other. It is customary to consider the vertical plane (V) as revolved into the horizontal plane (H), the ground line or line of intersection of the two planes still being present to indicate the relative positions of the two planes before the revolution took place. Fig. 4 will serve to explain how this revolution affects the projections of points taken in the different diedral angles. a^v, b^v, etc., are the projections of points a, b, etc, on the V plane. a^h, b^h, etc., are the projections of the points a, b, etc., on the horizontal or H plane. Hereafter the horizontal plane will be denoted by H and the vertical plane by V.

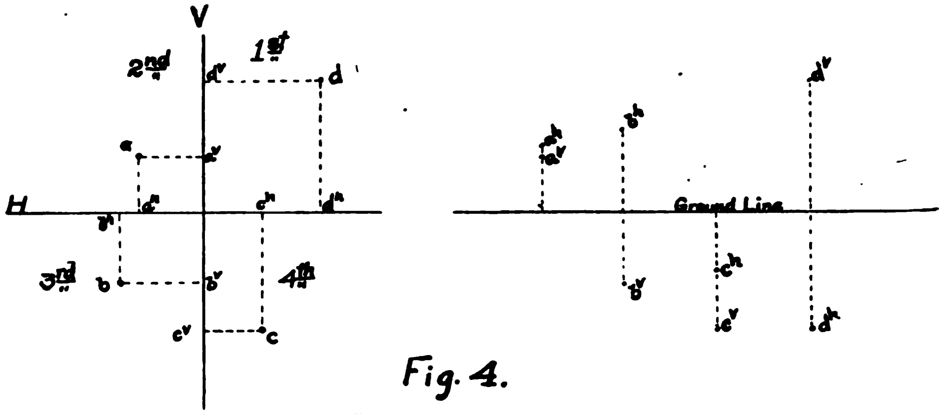


Fig. 4.

Shade Lines on Drawing.

TO make drawings easier to read, and to make the parts of the object stand out more clearly, shade lines are often used. The general principle which determines what lines shall be shade lines is the same as that which governs shade lines in orthographic projection. If, however, this theoretical principle were to be followed out exactly on drawings of machines and other complicated objects, it would involve a great deal of time and labor. Consequently, most draftsmen place shade lines on all lines which represent lower and right-hand edges.

The contour lines of cylinders, cones and other rounded surfaces should not be shade lines, although some draftsmen shade them. If the cylinder is drawn in cross-section, however, the edge should be shaded, as the intersection of the plane and cylindrical surface is a sharp edge.

All views are shaded alike, and both are shaded as though they were elevations. The ray of light is supposed to come over the left shoulder of the draftsman as he faces the paper, at such an angle that the projection of the ray of light on the drawing paper is in the direction of the arrow

Figs. 1 to 8 show some of the most common shapes met with in drawings, and illustrate how the shade lines are placed on each. Fig. 1 is an eleva-

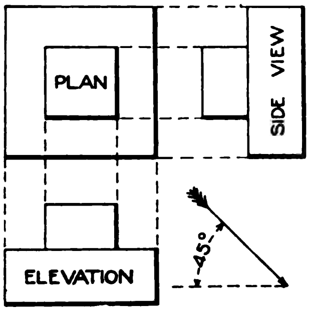


Fig. 1.

tion, plan, and side view of a rectangular prism with a smaller one resting on top of it. Fig. 2 is a plan and side view of a rectangular prism with a rectangular hole through it. It is to

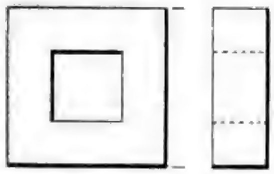


Fig. 2.

be noticed that the shade lines come on the upper and left-hand sides of the hole, since these lines are the lower and right-hand edges of the material which surrounds the hole.

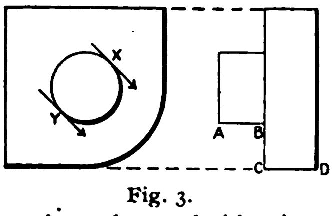


Fig. 3.

Fig. 3 is a plan and side view of a rectangular prism with one corner rounded, and with a cylinder resting on it. Here the lines A B and C D are not shaded, since they are the contour lines of curved surfaces. In the plan view, the lower right-hand part of the circle, between X and Y, is shaded. To find these points X and Y, draw two lines tangent to the circle and making an angle of 45° with the T-square line; X and Y are the points where the arrows are tangent to the circle.

Fig. 4 is a plan, elevation, and cross-section of a cylinder. Here, in the plan, the larger circle is shaded on the lower side, and the circle which

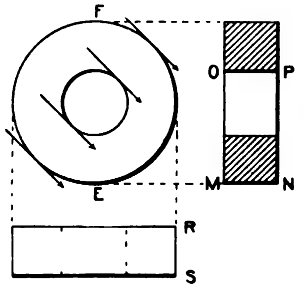


Fig. 4.

shade begins are determined as explained for Fig. 3. The lines M N and O P are shaded, since, as the cylinder is supposed to be cut open, these lines now represent sharp edges.
represents the hole is shaded on the upper side. The points where the

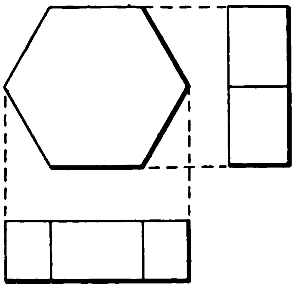


Fig. 5.

Fig. 5 is a plan, elevation and side view of a hexagonal prism, with its long diameter parallel to the bottom of the paper. Fig. 6 is the same, except that here the short diameter of the prism is parallel to the bottom of

the paper.

Fig. 7 is a plan and end view of a rectangular block, with a wide slot

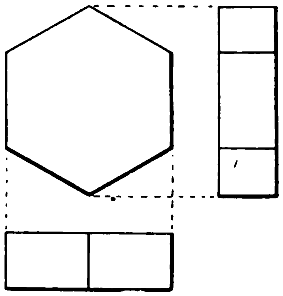


Fig. 6.

of the shape H I J K M L O N cut through it lengthwise. The main point to which attention should be called is that the line C D is shaded,

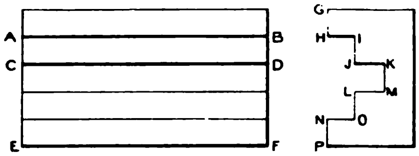


Fig. 7.

although the slot might be so deep that the light might not strike in there because of the shadow of the projecting lip marked in the side view G H I.

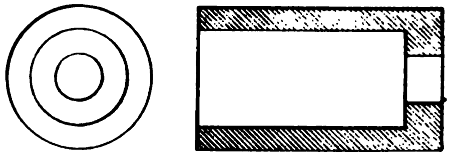


Fig. 8.

Fig. 8 is a cross-section and end view of a circular cylinder with a large hole extending part way through and a smaller hole extending the rest of the way. The small circle in the end view is shaded, although it is so far in that no light could strike it.

These simple figures show how the shade lines are determined, so that when similar forms occur in machine drawings the shade lines are easily placed.—*The Technical World.*

The Isometric Circle.

BY A. EDWARD RHODES.

FOR a number of years I have been using a graphic method for drawing isometric circles, both in the drafting room and in my school classes This method, Fig. 1, deserves to be better known. It possesses the merit of having fewer construction lines, and also of the ease with which the length of the major axis of the isometric circle may be made to equal the diameter of a given inscribed circle.

Illustration: Let it be desired to make an isometric drawing of an inscribed circle X diameter.

1st. With a radius X draw two circles touching as at A.

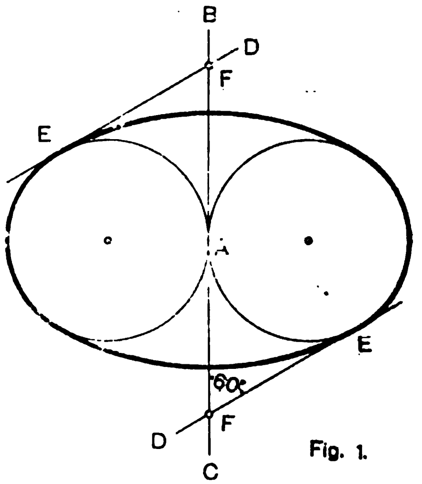


Fig. 1.

2d. Draw a tangent B C, common

to the two circles.

3d. Draw lines D at 60 degrees to the line B C and touching (tangent to) the circles as at E. This gives the centers E on the line B C.

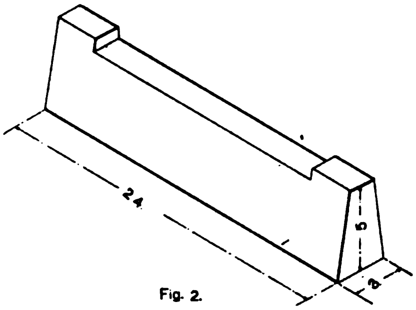


Fig. 2.

4th. Use F for centers and draw arcs cutting the circles at E, thus completing the curve. Suppose the inscribed circle to be 2″ diameter; then X—2=.5 of an inch, and the major axis of the drawing will be .5×4—2″.

From the above it will be seen that it is possible to make an isometric drawing of any inscribed circle by using a scale of standard inches, and without having recourse to a specially constructed isometric scale.

In regard to elevating the drafting board, I do not like the castings advocated by Mr. Babbitt in the January DRAFTSMAN, but would prefer, in fact use them in my night school, the wooden blocks shown in Fig. 2. This block costs less to make, anyone can make it, and it will not punch holes in the drawing board.

Editor The Draftsman.

Dear Sir: If you will allow me a little space in your valuable publication I will endeavor, for the benefit of the student of the "Home Study Department" to elucidate the problem published in the December issue, on pages 301-2. The writer there says, referring to the diagram on page 301, that K E equals C E, and asks at the close of his demonstration, "Where is the error in the proof?" The error is found in the assumption that K E equals C E. Now, if all those who do not know, and are interested in knowing, to the extent of constructing a diagram, according to the instructions which follow, the result tending to show whether the above assumption is true or false, will be so plain that he who runs may read. So get to work and spike down a piece of paper, about the size of the page which contains the diagram, and point up your pencils good and sharp; no ink will be needed. First, construct the square shown in the diagram, A B D C, and bisect the side D B, in G, and at that point erect an indefinite perpendicular, and on it from point G set off G E, equal to the same distance in the original, join E B and E D, also E C and E A. With B as center and A B as radius, describe a circle, the circumference will pass through the points A and D if you have drawn a square. On this circumference from A set off a distance equal to the arc A K in the original, and from that point draw K E and K B; now letter your diagram the same as that in the Draftsman, and then you can lay the publication aside. With E as center describe another circle, this latter circle will be tangent to the circle described about B at some point in its circumference, and to locate this point with precision you have only to prolong B E to cut the circumference.

The point of intersection will be the point required; denote this point by P, and we will denote the smaller circle by D, because it passes through that point, and the larger circle by S, which you may place near the circumference at any convenient point; denote the point where circle D cuts the line P E near E by letter N, and the corresponding points in the lines K E and A E by the letter O and M respectively. The two circles S and D are tangent to each other in the point P, that is to say, they touch each other in that point, *and in that one point only*, and every point in the circumference of circle D except P is within the greater circle S. Now P N is a diameter of circle D, for it passes through the center B; a diameter is also a chord, and it is the longest chord that can be drawn in the circle; also, K O and A M are chords, in the same circle, and of all the chords that can be drawn in any circle, that which is the greater subtends the greater arc, in your diagram. This statement is proved to be true by mere inspection, it is self-evident, for surely the arc P D N, being a semi-circle, is greater than are A D M, which is not a semi-circle, therefore the chord K O is greater than A M. The whole line P E is a secant of circle D; also K E, A E, and D E are secants to the same circle. Now, what has been said of chords applies to secants when drawn from a common point without the circle, as in the diagram, the greater secant will intercept the greater arc, the arc K D O is greater than arc A D M, therefore K E is greater than A E, hence they can not be equal, but A E is equal to C E by construction, therefore C E is not equal to K E. Points K and A are both on the circumference of circle D. When two triangles are equal and similar, if they be placed one upon the other so that corresponding sides will fall together, they will coincide in all their parts, and this is a test of equality often used in geometry, but the two triangles K B E and A B E will admit of this test, hence they are not similar, therefore not equal. Suppose the point E to be a fixed center, about which the triangle K B E may be made to revolve, while triangle A B E remains stationary, the side B E is common to both triangles, and in this case the side of one triangle coincides with the side of the other; but suppose the point K to move towards the point A when the side K E coincides with the side A E, the side of the triangle K B E, which corresponds to B E, will form an angle with the corresponding side of triangle A B E similar to angle A E K, and by no arrangement can all the sides of the triangles be brought into coincidence, therefore, the two triangles are not equal, but triangle A B E is equal to triangle C D E by construction, therefore, triangle C D E is not equal to triangle K B E. Much more that is interesting and instructive could be said about your diagram, but this article is already too long.

FLORENCE W.

DURABLE WOOD.

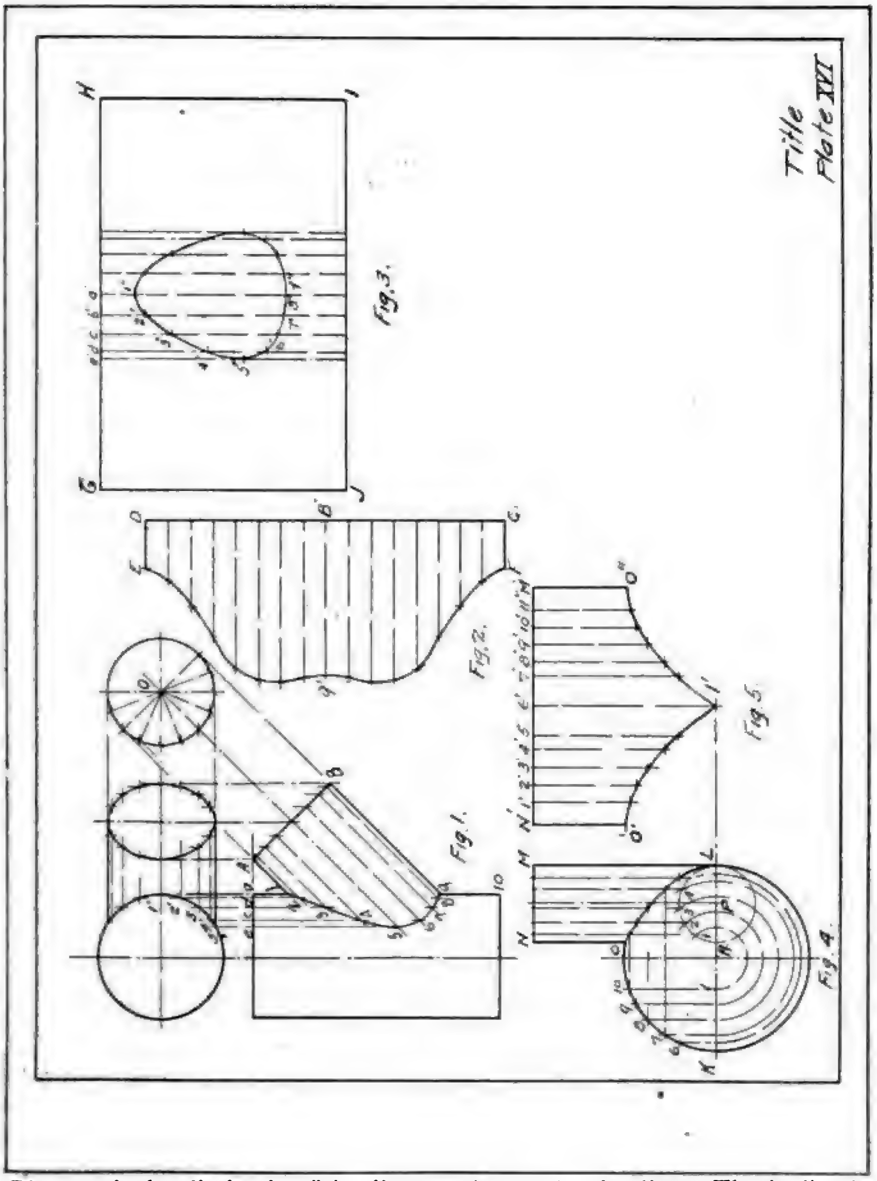
One of the most durable woods is sycamore. A statue made from it, now in the museum of Gizeh, at Cairo, is known to be nearly 6,000 years old. Notwithstanding this great age, it is asserted that the wood itself is entirely sound and natural in appearance.

Elementary Mechanical Drawing.

Continued from March.

PLATE XVI — Promblem I.

To lay out the development of two cylinders which intersect each other at an angle of 45 degrees.



The vertical cylinder is 2″ in diameter and the inclined one is 1¾″ in diameter. The center line of the top views is 2″ from each border line and the base of the front view is 7½″ from the top border line. The inclined cylinder intersects the vertical one at a

point ½″ below its upper face. Its length is determined by drawing AB, through A the intersection of 1, and the upper base of the vertical cylinder. O is the intersection of the center line of the inclined cylinder with the center line of the top views. With O as a center, draw a circle whose diameter is AB and lay it off into equal arcs as shown. Now project the points so found upon AB and draw the elements of the inclined cylinder. The ellipse which represents the horizontal projection of the end at AB is found by drawing vertical lines through the points already found on AB, and finding their intersections with a set of horizontal lines drawn through corresponding points on the circle about O.

This is called the horizontal projection because in using the third angle of projection the object is projected to the horizontal plane. It is projected *vertically,* but is *not* the vertical projection of the object.

The line CD, Fig. 2, is equal to the circumference of the inclined cylinder, and should be divided into the same number of parts. CD may be placed 8″ from the right border line and D, 1¾″ from the top border line. It will be seen that there are two element lines from CD of the same length and the curve will be symmetrical on each side of 9′, FC and ED being equal to AI and so on to B′ 9′, which will be equal to B9.

GH is the circumference of the vertical cylinder and GJ is equal to its length a 10. H is 1″ from either border line. Find the center of GH and lay off a′b′ equal to 1′2′, b′c′ equal to 2′3′, and c′ d′ equal to 3′4′ and d′e′ equal to 4′5′.

The same spacing should be made no the right of a′.

The lengths a′1″ will be equal to a1, a′9″ will be equal to a9, b′2″ will be equal to b2 and b′8″ equal to b8 and so on.

Draw in the curve through the points.

Promblem II.

A cylinder 1¼″ in diameter intersects the surface of a sphere which is 3″ in diameter. The center which is 3″ in diameter. The center of the sphere is 2″ from each of the border lines and the center line of the cylinder is ⅞″ from that of the sphere. Let the center line of the cylinder intersect the line KL and draw a circle equal in diameter to that of the cylinder, or MN. Let M′N′ be equal to the circumference of the cylinder MN. N′ is ½″ from M. A series of concentric circles are drawn in around R cutting the circles about P in points 1, 2, 3, 4, etc.

Draw vertical element lines from points 1, 2, 3, etc., through the cylinder, also draw the lines up to points 6, 7, 8, 9, and 10 and then across from these latter points to intersect the elements of the cylinder. This will give points in the curve of intersection of the cylinder and the sphere. N′ O′ and M′ O″ will each be equal to NO. Also N′ 1′ and M′ 11′ are equal to RI approximately.

PLATE XVII—Problem. 1

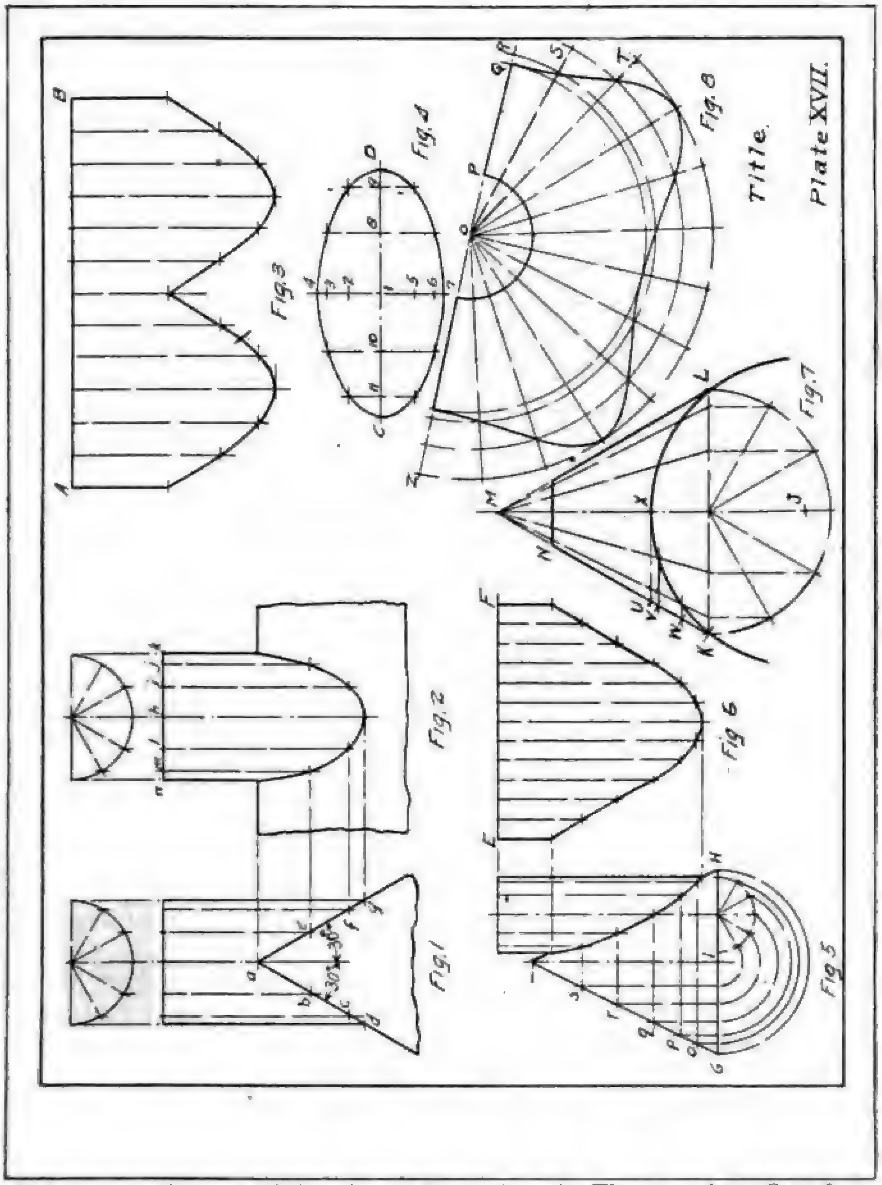
A 2″ pipe passes in through the top of a peaked roof. To find the shape of the curve of intersection of the pipe with the roof.

The center of Fig. 1 is 2″ from the left border line and the center of Fig. 2 is 4″ from that of Fig. 1. The peak

of the roof is $3\frac{1}{2}''$ below the top border and the top of the pipe $1\frac{1}{2}''$ above the peak of the roof.

To find the development of the pipe, find the circumference of the pipe and lay it out on line AB and then proceed as in the previous problem. AB is $\frac{1}{2}''$ below the top border line. Fig. 4 is a development of the hole through the roof. CD is $5''$ below the top border line and 4—7 is on the center of AB.

The lengths 1—C and 1—D are ac and ag in Fig. 1 and 1—8 and 1—10 are equal to ab and ac, 1—9 and 1—11 are equal to ac and af respectively. Then 1—2 and 1—5 are equal to hi



and hi and 1—3 and 1—6 equal to hj and hm and 1—4 and 1—7 equal to hk and hn respectively. Project these points and draw in the curve with the aid of the French curve.

PLATE XVII — Problem 1

A cone 3" in diameter by 3" high is pierced by a pipe 1¼" diameter set ¾" off the center of the cone. The base of the cone is 2" from the bottom border line and the cone is on the center line of Fig. 1.

Extend the center line of the pipe to line GH and draw the circle of the cylinder and divide it into an even number of parts and draw concentric circles about the center I through these parts. From the intersection with line GH draw lines to o, p, q, r and s. Draw horizontal lines from o, p, q, r and s and find intersections of these with the elements of the pipe and through these points draw the curve. The development of the pipe (Fig. 6) is found by laying EF off equal to the circumference of the pipe and by projecting across from points in the curve of Fig. 5.

Problem 3.

A conical pipe rests on a cylinder 5½" in diameter, the center of which is at J, ½" from the border line and 7¾" from the right border line. The apex of the cone is 3½" above KL and the cone is 4" at the base and 1" at the top in diameter, KL being 4".

Draw in the half circle from K around to L and divide as shown and project to line KL and draw in the elements. Draw horizontal lines from the intersection of the elements with the cylinder KXL to u, v and w.

Locate O, 3½" from the right border line and 6½" from the bottom border line.

From O with a radius of MN, draw the arc at P and with MU the one at Q, with MV the one at R, with MW the one at S and with MK the one at T. Then the arc T should be as long as the circumference of the base KL and divided into the same number of parts, in this case, twelve. The arc T may be extended into the margin of the sheet, so to cross the line RO which is determined by laying the line OZ up near Fig. 4 and stepping around on arc T until the proper number is secured.

The elements are then drawn in to the point O from these divisions on arc T and the points for the curve located as shown.

Common Mistake made by Draftsman.

BY J. HAYS.

IT sometimes occurs when you may have a hurry repair job which necessitates a drawing of which both pattern and piece in question have to be made.

In making the drawing, the draftsman has been very particular to make a neat finished drawing and has left out the principal part, the dimensions. Take for instance a piece of work coming in from a pattern which has to be made and then the castings finished, and as the piece cannot be left in the shop only long enough for a draftsman to do the drawing, the drawing is made and the pattern-

makei is requested to leave enough on for finish, as this drawing is also to be used in the machine shop.

The drawing is finished and given to the pattern-maker; first thing is, how long or how thick is this to be? No size or anything is given. Is this drawing made to a scale? Of course it is; then. I suppose if I scale the drawing it will be all right. The pattern-maker makes his pattern according to the drawing scale, then it is up to the machinist. He is supposed to make it exactly the size. Where will he get his size from? Guess at it, and nine times out of ten he wil' get it too small. He cannot measure the old piece, for that has been put back in the machine. The piece is finished as nearly as possible according to the directions given by the draftsman, and sent to the party ordering it. He is the one to find the mistakes and returns it to be made good. It is not his fault that it is made too small, and the consequence is, it will have to be made over again, and maybe the pattern also, gratis. Where does the boss come in? All his profit and more, too, gone, and whose fault was it? All on account of not putting in the proper dimensions.

A draftsman cannot be too particplar in being sure he has put in all the proper dimensions, and also enough different views to enable the workman to tell exactly what is wanted. Never mind putting on an extra lot of time lettering and finishing, for if the drawing has no dimensions given, it is nothing more than a picture, and no workman can work from a picture, a sketch on the back of an envelope with all the dimensions on it is better than all the drawings or blue prints you could mine the proper size under certain make without dimensions as far as working after it is concerned.

Hydraulics and Law.

The ridiculous position in which an engineer may find himself by following the "friction formulæ" is here reproduced from the expert testimony of a local hydraulic engineer, who was trying to explain the flow of water through long pipes.

Question. Mr. Expert, in estimating the flow of water in long pipes, how do you determine the friction, or resistance, to the motion of the water, caused by the interior walls of the pipe?

Answer. By the diameter, length, internal condition and curves of the pipe, together with the hydraulic head.

Ques. Then the longer the pipe, the smaller the discharge, and the slower the motion?

Ans. Yes, sir.

Ques. Should the pipe be long enough the friction would overcome the head and the flow would cease?

Ans. Yes, sir.

Ques. Then, if the water came to a rest, the resistance caused by the friction would also cease, would it not?

Ans. Yes, sir.

Ques. Would not the water start up again at full velocity?

Ryerson's Monthly.

CURRENT TOPICS.

Our Supplement.

While the supplements we issue each month are some additional trouble to us in preparing and inserting, it is believed that they are of such nature as to warrant a welcome by most every draftsman.

Some of the supplements to the future issues will be on standard machine and set screws, railing bases, rail and I beam washers.

The DRAFTSMAN has received several letters with money for subscriptions with no address in the letter.

Always be careful of this part when you write a letter; it will save time and money often, besides the inconveniences arising from the delays caused. Remember the address; if it is there and not the name, we can reach you.

About Draftsmen.

Whatever may be said against trusts, one thing noticeable is they always increase the number, the pay, and raise the standard of draftsmen at the plants retained in operation. If draftsmen are an "expensive luxury," they are the first men around the shop to go when business "lets up," for they are easy to get, thanks to the correspondence schools. Why should combinations have their chiefs hunt four to six weeks for one man to take the place of someone who has dropped out because a man does not count in a trust plant? Yes, the trust gets the credit with doing smaller things to increase profits, than any independent company would think of doing.

It isn't what you do that will hold you a position in so many plants, but the way you do it. Don't wonder why the last man into the room is retained after yourself and others are let go that the salary list in the engineering department be made in keeping with the amount of business done. Doubtless your assertion that results count may be true, but how did you create those results—like the old woman that kept the hotel in Indiana?

The Difference.

The difference between salary and wages is precisely the difference between accepting a position and getting a job.—Detroit Free Press.

Head draftsman L. D. Rosenbauer, of The Wolf Co., is home from a business trip to Richmond, Va.—*Chambersburg (Pa.) Repository.*

Oscar F. Mead, of Detroit, has been appointed a draftsman in the United States patent office at $1,000 per annum.

There is a great demand at the present time for brick making machinery in Cape Colony, Natal, Orange river colony and the Transvaal.

The Oldness of Things.

When one stops to think of the numerous technical articles that are published now and the difficulty in obtaining entirely new matter so that the old readers may not say "Oh, that is old; I knew that twenty years ago," we wonder what will be next.

There are always experimenters like Hewitt, Currie and others that are bringing out some new things to talk about that all our matter is not old, yet that which is repeated is clothed in a new style and appears new to many.

A good thing should never grow old and in repeating it in a new dress often an idea comes to the reader that never appeared that way before.

What if some article does have an old appearance, one must remember that there are more readers that have never seen it than have.

In arranging matter for publications a writer often takes up a subject old to him and sometimes to others, yet he could not well write on something with which he is not familiar. Suppose he rehash some article, add his views and a few sketches to it, he has made it clearer for someone perhaps who is less favored with a quick perception.

Then, too, a writer should not leave the reader to guess too much, even if the matter under discussion is as old as the hills.

In looking into many text books, we find formulæ plain and simple, yet which mystifies many readers because some little explanation is lacking.

For instance, in some books on design where the formulæ have been derived from experience and arranged to fit most practical cases, parts of them are based on the size of some body generally known, say the diameter, but to it is added ¼, 1-16 or 05, as the case may be.

Now the writer thinks that the reader will understand that you simply add these for looks, not strength, and it is such an old thing that it needs no explanation.

It might be said here that these formulæ are often more confusing than useful, and a word about this might not be amiss.

Suppose we had an expression $t = .02d + .5$ for the thickness of an engine cylinder in which d is the diameter. Then if d was to be 10", we multiply .02 by 10, which gives 0.2 and adding .5 makes .7 and call it inches. If d was in centimeters, then the answer would be .7 centimeters.

Not long ago we saw a copy of a trigonometry that had in the text many letters of the Greek alphabet, but on the fly leaf of the book was found the names of the letters.

Old, yes, old, about 2,500 years old, but absolutely necessary that it was repeated again for the benefit of the reader.

Some of our text books have an old way of showing proportions of parts in designs of different machines.

The object is proportioned to a certain *unit;* we see a note that the unit is D or the unit is $D \times 1.15$, meaning that all the figures in the illustration are to be multiplied by the value for D or the result of $D + 1.15$, and if D be in inches, the final result is in inches.

So we find many old things not explained. The writers are bubbling

over with the subject in hand that they forget that all minds are not alike and able to see as readily as he, who has generally set up nights to absorb a large supply of that particular theme.

The old things are new to many, to a great many, we might say, and should never be cast aside when clearness is desired.

The Thermometer Scale.

How It Happened to be Divided in an Apparently Senseless Way.

WHY should the freezing point be marked 32 degrees and the boiling point 212 degrees on the Fahrenheit thermometer scale? Most students know that its inventor divided the space between these points into 180 degrees instead of the simpler 100 degrees used in the centigrade system, but few understand how this number came to be chosen. A writer thus explains the matter:

The thermometer was really invented by Sir Isaac Newton. He started his scale with the heat of the human body and used as his instrument a glass tube filled with linseed oil. The lowest figure on the scale was the freezing point and the highest point boiling water. The starting point of this scale, as mentioned, was the heat of the human body, which he called by the round number 12, as the duodecimal system was then in common use. He divided the space between the freezing point and the temperature of the body into 12 points, and stated that the boiling point of water would be about 30, as the temperature must be nearly three times that of the human body. .

When Fahrenheit took up the subject a few years later he used the Newton instrument, but, finding the scale not fine enough, divided each degree into two parts, and so made the measure between the freezing and boiling points 24 instead of 12. Fahrenheit then discovered he could obtain a lower degree of cold than freezing, and, taking a mixture of ice and salt for a starting point, he counted 24 points up to body heat. By this measurement he obtained 8 for the freezing point and 53 for the boiling point. His scale now read: Zero; freezing, 8: body heat, 24. and boiling water, 53. It will be noticed that this scale is identically that of Newton's, only starting lower and having the numbers doubled,

It was with this scale which Fahrenheit worked for a long time, but finally finding the temperature divisions still too large, he divided each degree into four parts. Multiplying the numbers just given by four, the thermometer scale now in use results.

The chance choice of Newton of the figure 12 to represent the body heat determined the present thermometer scale, even as the yard, feet and inches measures originally came from measures of parts of the human body, and as the width of the railroad carriage was determined by the track, which, in turn, was determined by the width between the cart wheels necessary to bear a load which could be comfortably be drawn by a mule.—***American Inventor.***

Spurns Flag as Sign of Liberty.

With the Stars and Stripes reflecting their colors in his eyes, no matter toward which wall he turned, William D. O'Brien, toastmaster at the banquet of Contractors and Builders at the Auditorium hotel refused to toast the flag as an emblem of liberty.

"Why the emblem of liberty is a farce," he cried, "when men are shot down in the street because they are trying to earn an honest living; when we are afraid to assert our rights for fear some labor organization will oppose us."

The banquet hall was thronged with delegates to the national contractors' conference and members of the contractors' council of Chicago, by whom the feast was spread, and, as Toastmaster O'Brien uttered his opinion of what he characterized a fettered liberty, the big hall was made to echo with cheers of approbation.

"It is ridiculous," he declared, "to think you should be obliged to waste your time discussing your rights with walking delegates, business agents and labor leaders. You have your rights, and no man should be able to step in and dictate to you and tell you where your rights begin and end.

"We want to make this national organization so strong that it will never again be necessary for us to confer day after day with labor leaders to obtain our rights.

"If a man is not a union member and is loyal to you, you must be loyal to him. We must be able to obtain liberty in every sense of the word, and not merely privileges. The conditions are disgraceful which make it necessary for us to consult with our employes at every step."

Contractor William Grace, of Chicago, declared that he was tired of being told what to do by Gompers and Mitchell and other labor leaders.

Mr. Grace declared that the running of the United States' mail cars without police protection during the recent strike had made him think that his rights and the rights of every American citizen were just as sacred as the mail cars.

By other speakers, all the troubles of the builders were laid at the door of organized labor. The feeling for the "open shop" was strong.—"*Keith's Magazine.*"

A cotton picker machine has been invented which, it is claimed, will save one-third of the crop and the wages of twenty-eight men.

Last year 5,723 miles of new steam railway track were built in the United States. That was thirty-nine miles more than the total mileage constructed in 1902.

Cramps Draftsmen at Dinner

Draftsmen employed in the several departments of the Cramp Shipyard, Phila., Pa., had their annual dinner Friday evening at the Hotel Garrick, where covers were laid for 50. Axel Russell acted as chairman and the speakers were J. W. Rhoder, W. C. Nickum and W. H. Rogers. The committee in charge of the affair consisted of W. A. Leavitt and W. K. B. Potts.

A Common Mistake.

OUR bright and able contemporary, "The Draftsman," has introduced a department for "Home Study," and its first series of articles is "A course in Elementary Mechanical Drawing," which contains many good practical hints. But we were a little surprised when we read the following passage, coming from such a source:

"The T-square should be used for drawing horizontal lines only. Its head should always be placed upon the left edge of the board. Vertical lines should be drawn by the use of a triangle placed upon the T-square and not by means of the T-square only; because the edges of the blade of the T-square are often not at right angles to the head, so that lines at right angles to each other will not result from the use of the T-square upon all edges of the board."

Now the fact is that it does not make the slightest difference whether the blade of the T-square is, or is not, at right angles with the stock or head. The relation of horizontal and vertical lines to each other, so far as being at right angles to each other is concerned depends wholly upon the corners of the drawing board and when the T-square is applied consecutively to the left hand and under edges of the drawing board, the direction of the lines then drawn is governed by the lower left-hand corner. If that be a right angle, the lines will be at right angles to each other, whether the T-square is a true square or not.

The idea that the blade of a T-square must be exactly at right angles with the stock is a very common one, but it is a mistake nevertheless, as a very little reflection will show to those who have a slight knowledge of geometry. The subject was discussed very fully in our issue for June. As for using the T-square for drawing vertical lines, that is often necessary, and there can be no objection to doing so provided the drawing board is right. At the same time every draughtsman knows that for vertical lines, of ordinary length, the set-square is the most convenient tool.

It is easy to test the truth of our statements by using a square with a movable head or a bevel-square, as it is called. Let the blade of such a square be set so that it is obviously not at right angles to the head and then draw vertical and horizontical lines by means of it. Test these lines by any of the well-known geometrical constructions, and if the corner of the drawing board is a right angle the lines will be found to be at right angles to each other. This is the most accurate and simple method of testing a drawing board. To test the square itself when it is made as directed both by "The Draftsman" and "Self-Education" is not such a simple matter and would require more space than we can afford for this note:

"The Draftsman" is usually so accurate and its directions are so judicious that the above lapse is all the more extraordinary, but we have had similar accidents happen to ourselves over and over again."

The above is quite true and the writer of the part from The Draftsman admits that that is not as well expressed as it should have been, so we

feel grateful to the editor of Self-Education for the attention given it. So we will say "The T-square should be used for drawing horizontal lines only. Its head should always be placed upon the left edge of the board. Vertical lines should be drawn by the use of a triangle placed upon the T-square and not by means of the T-square against the lower edge of the board, because the corners of the board are often not at right angles with each other.

Promoted Draftsman.

Albert J. Stibolt has been appointed by Colonel J. L. Lusk to the position of chief draughtsman in the office of the Government Engineer's office in this city, succeeding to the vacancy occasioned by the death of Henry P. Bosse. The promotion, which carries with it a neat increase in salary, is a deserved one, Mr. Stibolt having served the government for a quarter of a century.—*Rock Island, Ill., Argus.*

Every man has two educations—that which is given him and the other that which he gives himself. Of the two kinds, the latter is by far the more valuable. Indeed, all that is most worthy in a man he must work out for himself. It is that that constitutes our real and best nourishment. What we are merely taught seldom nourishes the mind like that which we teach ourselves.

JOHAN PAUL FREDERICK RICHTER,
(Eighteenth Century.)

Photography Without a Camera-Copying Drawing.

For copying small but elaborate drawings like Patent Office drawings there is probably no method so quick, accurate and cheap as the following, says a writer in *American Machinist.*

Procure a photographic dry plate of the size required (8x10 is usually large enough for Patent Office drawings, the rest of the sheet being taken up by margins, title and signatures). Place the drawing and plate in a printing frame, the drawing with the back side out, so that the lines will be in contact with the film on the plate. This must be done in a dark room. Expose the frame to dim daylight for a period of, say, five seconds at a distance of about 10 feet from a north window or one through which the sun is not shining. Develop with the following:

No. 1. Hydrochinon Solution.—(a) Water, 13 ounces; sulphite soda crystals, 1 ounce. (b) Water, 2 ounces; sulphurous acid, ½ ounce (not sulphuric).

Add solution (a) to (b) slowly, then add: Hydrochinon, 100 grains; bromide potass., 30 grains.

No. 2. Alkali Solution.—Water, 5 ounces; carbonate soda (dried), ½ ounce; carbonate potass. (dried), ½

A beehive coke oven, in full blast during the world's fair, will be one of the exhibits presented by Kentucky. The Blue Grass state has 6,000 square feet of floor space in the palace of the mines and metallurgy.

Draftsman Named.

MEN APPOINTED TO POSITIONS IN THE DEPARTMENT OF INTERNAL AFFAIRS.

W. M. Mooie, of Clearfield, and C. Templeton Ritter, of Allentown, have been appointed draughtsmen in the department of internal affairs and ordered to report for duty next Monday. The last Legislature appropriated $20,000 for the employment of additional draughtsmen in this department, and Secretary Brown has appointed eight altogether.

There are numerous applicants for these positions, but the secretary has decided to make no addition appointments unless there should be vacancies. —*Harrisburg Dispatch.*

What he Says.

The Draftsman.—Your persistency in sending me sample copies of "The Draftsman" has finally convinced me that it is a splendid little publication, and enclosed you will find check for one year's subscription to still help it along to further success.

Very truly yours,
W. NEVIN FLICKINGER.

Mr. L. E. Woglemuth, heretofore chief draughtsman of the Chicago, St. Paul, Minneapolis & Omaha, has been appointed mechanical engineer, with office at Saint Paul, Minn., to succeed Mr. B. R. Moore, who has been appointed assistant superintendent of motive power and machinery, with headquarters at Sioux City, Ia., succeeding Mr. F. M. Dean, resigned.

Chief Draftsman to Go.

W. G. COREY FOLLOWS APPLEYARD FROM CONSOLIDATED'S CAR DEPARTMENT.

Following upon the retirement of Master Car Builder W. P. Appleyard from the car department of the Consolidated Railroad, which office it is said will be abolished, came the announcement to-day that Wilbur Graham Cory, the chief draughtsman and mechanical engineer in the same department had resigned.

Mr. Cory is a well-known resident of New Haven. He was educated at Washington University, which he left in 1888, entering the service of the Pullman Company at the St. Louis shops. He was with that concern engaged in his line of work until 1895, when he became supervisor of drawing room and sleeping car repairs on the Consolidated Road. Since 1896 he has been chief draughtsman and mechanical engineer on the road.

He has many friends in this city. His term of service with the road ends Saturday.

Editor The Draftsman, Cleveland, O.:

Dear Sir:—Referring to your geometrical problem in the December number, the arc A K as shown in the figure cuts the line B K a little short of where it should. With a radius A B and center at B the line A K would be longer than shown and the lines E K and C E would not be equal. Then the angle C D E would not be equal to the angle B E K and the angles K B D and B D C would not be equal.

Yours, etc.,
M. C. HURD.

Duplex Instruments.

The illustration shows clearly the make-up of the Duplex Drawing Instruments handled by Mr. N. A. New-

ton, 114 Central Ave., Oil City, Pa., and it will be seen that each instrument has many good qualities.

The compass on the left of the illustration is provided with a lengthening bar as shown on the right and will answer for quite large circles.

The second instrument from the left is arranged with lead, a pen and two points which allow it being used as a pair of dividers.

The next one is simply the compass with lead and pen point and is not arranged for extra bar. The top instrument is what is commonly called bow-pen and pencil and is very neat and convenient.

The instruments are well made and highly finished and are great time savers, and are just what a rapid draftsman should have to aid him in his work.

For further information about these instruments, write Mr. Newton.

An unrecorded occurrence of last Friday is brought to light by the presentation to B. J. Carnes, draftsman of the state land office today, of a leather medal in the shape of a shield on which is inscribed: "To B. J. Carnes for Saving the Life of W. H. Pierce."

Mr. Pierce is employed in the secretary of state's office, and rooms at Mr. Carnes' residence, 406 Pine St., S. Mr. Carnes was awakened about 3 o'clock last Saturday morning by the smell of smoke. Investigating, he found the source of it was the room in which Mr. Pierce was sleeping. A lamp which Mr. Pierce was accustomed to leave burning all night was giving off the fumes which made the bed-room look like the top story of the most wicked place. The householder lost little time in getting his roomer out of his slumber and his room. Mr. Pierce was quite sick and has not yet gotten over the ill effects of the occurrence.

Everyone in the land office has heard about Mr. Carnes' medal, which is cleverly made.—*Lansing (Mich.) Republican.*

Two city jobs were handed out yesterday. Lloyd Moffat is appointed a draftsman and Henry Martin is made a machinist in the water department. —*St. Louis World.*

Erith's Engineering Company, London, have got possession of an automatic stoker as a specialty, and as it is certain to come largely into use, it will effect that great improvement in smoke consumption and fuel economy which has been so long desired.

Photography without a Camera.

(Continued from page 183)

ounce.

To develop, mix 3 ounces No. 1 with 1 ounce No. 2.

If the exposure has been correct the development will proceed slowly until the background is as black as ink, the lines remaining clear white in the negative. Fix and wash as usual. Brilliant blue prints may be made from these negatives, showing sharp blue lines on a white ground.

W. H. S.

Electric Bolts in War.

To destroy armies by lightning is thought by Emile Guarani, a French writer, to be a possibility. Receiving a shock from a wireless telegraph apparatus through an umbrella, he experimented with a Rühmkorff coil, and found that shocks could be transmitted through the air with moderate currents. He concludes that the energy of 1,000 horse power, at 100,000 volts, could be concentrated by antennae so as to destroy life at a distance of 12 miles. The present difficulty, which he believes will be soon overcome, is that of controlling and directing the electric waves.

I have taken your magazine from the first number and find it one of the best I have ever seen for practical everyday "hints" and information in detail on all subjects pertaining to the drafting table.

C. R. MILLER, Galion, O.

Personals.

Franklin Farrel, Jr., the son of a Connecticut millionaire and a recent graduate of Harvard, has entered his father's foundry at Derby with the purpose of learning the trade of a foundryman in all its details.

H. C. McCann has resigned his position as draughtsman in the Wisconsin Central offices to take up a course of study in the machinery department. His position will be taken by Garth G. Gilpin.—*Commonwealth, Fond du Lac, Wis.*

Chief Draughtsman Robert D. Coombs, of the Pennsylvania Steel Company, has resigned to accept a position as assistant bridge engineer of the New York, New Haven & Hartford Railroad Company. Mr. Coombs' successor will be E. T. Holler, who was formerly chief engineer of the American Bridge Company's plant at Pencoyd.—*Philadelphia Press.*

WINNER.

Two young men are making a fortune in New York City taking contracts to polish tarnished gas fixtures. The following is the recipe of the metal polish which they make and use:

Muriate of ammonia..4 drs.
Oxalic acid ....1 dr.
Vinegar ....1 pt.

Dissolve the oxalic acid first, when mix all and apply with a soft brush, having work clean and bright.

Dear Sir:—Your favor of the 27th to hand for which please accept my thanks. I was much pleased to note that you accepted my print and more so that you entered my name on

your subscription list. I would ask that you please send me some sample copies of your February issue as I think I can do some business for you. Please start my subscription with the Jan. issue.

A little "kink" comes to my mind in reference to cleaning a tracing of pencil marks, dirt, etc., without injuring the ink in the least, which I think is not genally known and therefore would be very useful to the readers of "The Draftsman."

It is as follows: Take a piece of cloth, saturate it with benzine and wash the tracing. If you can make use of it, would be pleased to have you acknowledge it.

Anything I can do for the success of "The Draftsman," will be pleased to do it.

Thanking you once more for past favors, I remain,

Sincerely yours,

JOHN GRAHAM, JR.

Dear Sir:—Accidently I got hold of a copy of your "Draftsman" and must say I like it very much and would like to have you send same for one year to me under above address. Enclosed please find one dollar.

I would like to hear from you also if you have single copies of 1902 and 1903 yet, and how much you charge for same.

Hoping to hear from you soon, I am, Respectfully,

VICTOR R. A. STROH, Ch. Dr.

L. H. Yeager and Charles G. Tice have returned from a trip to Baltimore.

Claude Mengel, draftsman with Ruhe & Lange, architects, and Miss Helen Kopp, of Reading, will be married next Wednesday by Rev. Dr. B. Bausman.—*Allentown (Pa.) News.*

Chicago, Feb. 12, 1904.

Dear Sirs:—Enclosed please find money order for one dollar, for which renew my subscription for one year.

I have enjoyed reading it for the past year and have found it very useful, and it is getting better all the while.

Wishing you success, I am,

Sincerely,

H. W. GOODENAU.

Chicago, Feb. 15, 1904.

Dear Sir:—Enclosed find 10 cents in stamps for which please send me a copy of the "Handy Lumber Tables."

Every one of the boys seem to feel that "The Draftsman" has no equal. It certainly fills a long felt want.

Wishing you success, I am,

Yours truly,

J. HERBERT HOPP.

Herbert A. Wright, draughtsman at the Fauber factory, and Miss Marie T. Hylen, for the last eight years an employe of the watch factory, were united in marriage December 31, at 1468 Halsted street, Chicago. Rev. John Thompson, of Grace M. E. Church, performed the ceremony in the presence of twenty relatives and intimate friends. The bride and groom are well and favorably known to a large number of Elgin people, who unite in extending hearty congratualtions. Mr. and Mrs. Wright will reside at 227 DuPage street.

Books and Pamphlets.

Modern Wiring Diagrams and Descriptions for Electrical Workers tells how to wire for call and alarm bells. For burglar and fire alarm, How to run bells from dynamo current, How to install and manage batteries, How to test batteries, How to test circuits, How to wire for annunciators, for telegraph and gas lighting. It tells how to locate "trouble" and "ring out" circuits. It tells about meters and transformers. It contains 30 diagrams of electric lighting circuits alone. It explains dynamos and motors; alternating and direct current. It gives ten diagrams of ground detectors alone. It gives "Compensator" and Storage Battery installation. It gives simple and explicit explanation of the "Wheatstone Bridge" and its uses as well as volt-meter and other testing. It gives a new and simple wiring table covering all voltages and all losses or distances, etc., etc. 160 pages, over 200 illustrations, Full Leather Binding, Round Corners, Red Edges, Pocket Size 4x6. Price, Net $1.50. Published by Frederick J. Drake & Co., 211-213 East Madison St., Chicago, Ill.

A greatly enlarged edition of "Hand Book on Practical Mechanics" has appeared.

This pocket book manual contains answers to tough problems and questions that come up every day in the machine shop and drafting room, and they are all figured out by simplest methods in arithmetic. There are also to be found more practical reference tables than are contained in all the so-called Mechanic Hand Books bound together in one volume. Many tables and valuable shop "kinks" are taken right from note-books of the best mechanics in the country. This book is published by Charles H. Saunders, 216 Purchase St., Boston, Mass. Price, post-paid, $1.00 in cloth, $1.25 in leather with flat.

Engineers and Surveyors.

TABLE BOOK.

This neat leather-bound book contains table of Logarithims of numbers, Logerthimic, Sines and tangents, national sines, cosines, tangents and cotangent, traverse table, squares, cubes, square and cube roots, circumference and areas of circles, etc., all well arranged and printed. There are 18 pages, 3¼x6½ in., price $1.50. The book is published by the Wm. E. Stieren Co., 544 Smithfield St., Pittsburg, Pa., who will give further information.

The catalogue of Federal Blue Printing Machines show apparatus for making blue prints by very convenient and rapid method. Without the use of plate glass in the front. The Spaulding Print Paper Co., 44 Federal St., Boston, Mass., as the main factories.

The Velocity of Radium.

The latest wonder of science, radium, is now believed in some quarters to be the substance of which the sun is composed. Light travels at the rate of 186,000 miles a second. Considering that the brain can scarcely grasp the speed of a bullet, a mere 650 yards a second, it is readily seen how far beyond human comprehension is such a speed as this. Nor is it any easier to grapple intelligently with the speed of the emanations of radium, some of which fly off at a velocity of 120,000 miles a second, and will penetrate steel and various other substances as easily as smoke will pass through muslin. So powerful are these rays that it would be as dangerous to approach radium in any quantity as it is to go near gunpowder with a lighted match. A man entering a chamber containing a pound of radium would have his eyesight destroyed, his skin burnt, and would probably lose his life.

Artificial Building Stone.

Houses of sand, as substantial as granite, are offered by the new process of Mr. L. P. Ford, of Gresford, England. A mixture of sand and quicklime in suitable proportions is forced into a very strong steel mold, which is placed in a box, from which the air is then pumped, when hot water is admitted. The heat and pressure of the slacking lime and steam mold the materials into a rock having 60 per cent. of the strength of granite. This building stone, ready for use in eight hours, is very durable, and its cost is low, bricks by this process costing little more than half as much as the ordinary.

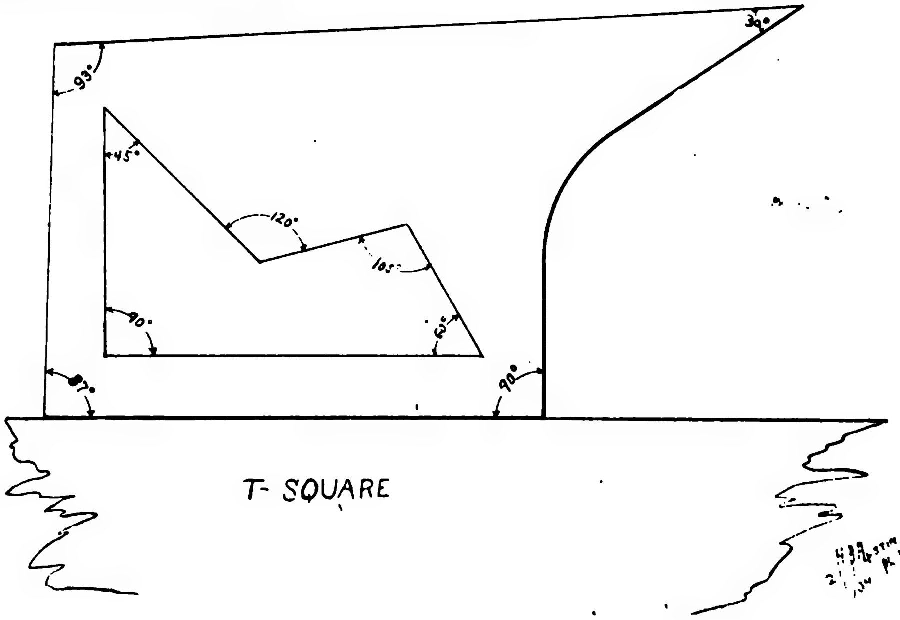
Improved Steel Castings.

For producing steel castings free from blow-holes, M. Meslan advises adding an alloy of aluminum and calcium to the molten metal. He has found that the combination of these two metals absorbs all gases present.

A Handy Triangle.

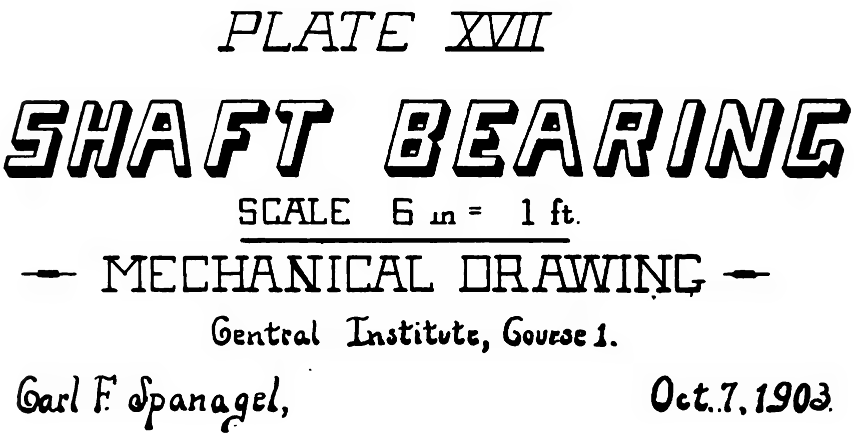
With an odd piece of celleloid one can make a very handy triangle if it is cut to the shape shown.

Mr. Austin, a reader, offers it as sample of what can be made from th scraps of larger triangles, or fro other material.



A Drawing Title.

A variety of neat lettering is shown in the accompanying illustration of title for a drawing.



THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

A High School Drafting Room.

(BY E. A. RHODES.)

Fig. 1 shows a modern high School drafting room that for fitness of purpose, I beleave is not excelled by any similar school. The room is 22 feet wide by 45 feet long and 15 feet high. It is lighted by large windows on left side of students. There are 45 drawing tables, adjustable for height and angle and may be rotated. The student may stand or sit as he may prefer or as may be required by his drawing. The tables each have a round base and a foot rest. The seats have rubber tips to permit their being moved without much noise. Each drawing room table is provided with a drawing-board, a tee-square, a 45° and 60° triangle, curved ruler, scale, writing-pen, and bottle of drawing-ink. There are two sets of lockers, like the one shown at the rear of the room for holding supplies, finished work, etc.

Fig. 1.

Fig. 3.

After much thought, it was decided to try as an experiment, to have the several students that use the same drawing-table use the same drawing board.

Our object was to dispense with a large rack holding about 400 drawing-boards and incidentally to have less noise when changing classes. The scheme is worked out as follows: There are five rows of drawing tables, nine to the row, and usually six classes each day. For each row of tables, one boy for each class is appointetd to distribute the unfinished drawings as the class enters the room. The same boy collects the unfinished drawings at the end of the drawing period. The time required for a class to receive its papers and start work is not more than one, or sometimes two minutes. To collect the papers and for the class to get ready to leave the room requires about two minutes for a class of forty students which is much less than was required by the old plan of each boy having his own drawing board.

The school also provides drawing pencils and erasers. We have found the best plan was to provide blocks like figure 2, one for each row of drawing tables. These blocks have holes for as many pencils and erasers as there are drawing tables in the row (nine). The boy that works at No. 1 table has charge of the pencils and erasers for his row of tables, he distributes them immediately upon entering the room, and collects them the last thing before leaving it. For the drawings of the manual training lessons (wood and iron) we use paper 7½"x10" and 10" x 15". For larger special drawings, we have boards to which the drawing paper may be fastened until the drawing is finished. For the two smaller sizes, we usually use but two thumb tacks, one in each of the upper corners of the sheet. To collect the papers, we ring a warning bell two minutes before time for class to leave the room, immediately each boy stops drawing, takes out his thumb tacks and the drawing pencils and erasers are collected by those in charge of the row, starting at number 1, then collecting at No. 2, No. 3, and so on. When collected, they are placed upon the front tables from which they are collected and placed in a locker where they remain until time for the class to again take up the work. The tee-squares hang under the desk in a position easily reached and on a hook so shaped that the tee-square will slip off before the blade will split. Not many of the students spill ink because the ink bottle is never removed from the stationary block provided for it on the front of the drawing table.

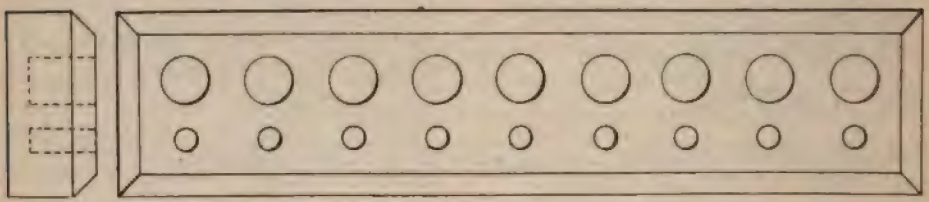


Fig. 2.

Fig. 3 shows a class of first year boys at work, an interesting feature of this picture is the boy in front moisting his pencil to lay off a measurement, a habit that sometimes requires considerable effort to overcome.

MECHANICAL.

The Cylinder Design of a Compound Engine.

By Robert R. Abbott.

IN correctly designing a compound engine, two things are of fundamental importance: First, the work done in the H. P. and L. P. cylinder should be nearly equal. Second, the total initial pressure on each piston should also be nearly equal. We will consider here a method for correctly designing a compound engine, considering only these two points.

Let us assume the following data for an example:

Non-condensing engine,

Steam pressure 160 lbs.

Releasing at 20 lbs.

Back pressure 16 lbs.

All pressures absolute.

This will give us 8 expansions since we will consider the steam to expand isothermally, that is at a constant temperature. We will now draw the combined theoretical indicator diagrams, considering the volume of steam at cut off as one cubic foot. This diagram is given in Fig. 1. The figures at the left are the pressures.

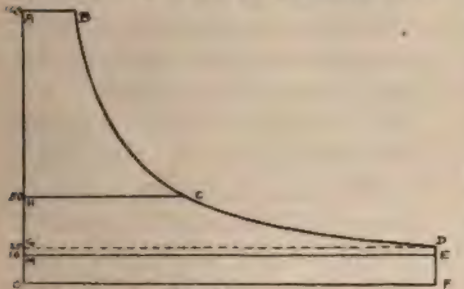


Fig. 1.

The work done by the steam in both cylinders is represented by the area 'ABCDEM, and our problem is to divide this area by a line parallel to EM such as HC, which shall represent the receiver pressure and at the same time make the area of the two parts of the diagrams practically the same. To begin with, substitute in the formula:

$$\log \frac{V_2{}^2}{E} = \frac{1 - \frac{P_4}{P_1} E}{2.3026}$$

in which V_2 is the volume represented by the line HC, our required line. P_4 is the back pressure, P_1 is the admission pressure and E is the number of expansions. If you have a table of hyperbolic Logarithms, the formula can be used without the 2.3026. This substitution gives us the following:

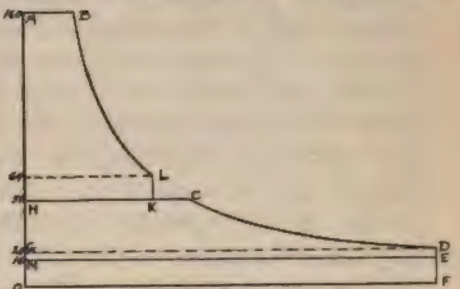


Fig. 2.

$$\log \frac{V_2{}^2}{8} = \frac{1 - \frac{16}{160} 8}{2.3026} = .08682$$

The number corresponding to the log. .08682 is 1.1221, our formula therefore becomes $V_2=3.13$. The pressure corresponding to this volume is now obtained by dividing our boiler pressure by it; this gives us 51 lbs. This means that in order for both cylinders to do the same amount of work, the receiver pressure should be 51 lbs., considering the H. P. cylinder to release at receiver pressure, but since this would not be practicable, let us draw the line HC, Fig. 1, through the 50 lb. line; the reason will be shown later.

Let us now turn our attention to the initial pressures. The initial pressure is either cylinder tending to move the piston would be the net steam pressure multiplied by the piston area; if the stroke in both cylinders is the same the two piston areas would have the same ratio as the volumes of the cylinders at release, so if we multiply the net pressure in either cylinder by its respective volume, the product will be the relative initial pressure. The length of the line HC represents the volume of the steam in the H. P. cylinder at release, and to the same scale the line GD. represents the corresponding volume in the L. P. cylinder, therefore, the initial pressure in the H. P. cylinder is $110\times3.13=344.3$; and in the L. P. cylinder is $34\times8=272$. Our initial pressure in the H. P. cylinder is evidently too high; this can be decreased by decreasing the piston area and consequently the volume. Divide the 272 by 110 and we get approximately 2.5, in other words if the volume in the H. P. cylinder at release is 2.5, the initial pressure would be nearly equal. The pressure corresponding to the volume of 2.5 is $160\div2.5$, which equals 64. We will now draw another card for these new conditions. It will give us a diagram similar to Fig. 2.

It is apparent that to make the initial pressures equal, we have had to cut the triangular part LKC from the H. P. cylinder work diagram, however in the first place we purposely drew the line HC slightly lower than it should be in order to allow for this.

The work in the two cylinders is now proportional to the areas ABLKH and HCDEM. We will find these relative areas by substituting in the formula: Area$=$P. V. $(1\times2.3026 \log \frac{V_2}{V_1})-P_2 V_2$ in which P_1, V_1, and P_2 V_2 represent the pressure and volume at cut-off and release respectively.

H. P. area $= 160\ (1+2.3026 \log. 2.5)\ -50\times2.5=181.6$.

L. P. area $= 160\ (1+2.3026 \log. 2.556)-16\times8=182.1$.

The work done in either cylinder is evidently practically equal. Let us see about the initial pressure.

H. P. cylinder $= 110\times2.5=275$.

L. P. cylinder $= 34\times8 = 272$.

The initial pressures are also close enough for practical purposes.

Our engine would therefore be made with a cylinder volume ratio of 2½ to 8, cutting off at 2/5 stroke in the H. P. and about ⅜ stroke in the L. P. cylinder, releasing at 64 lbs. in the H. P. and 20 lbs. in the L. P. cylinder and having a receiver pressure of 50 lbs.

Reclaiming Waste Flue and Furnace Gases.

By George E. Walsh.

THE fuel saved by means of economizers and the utilization of flue and furnace gases in the gas engine represents in the aggregate an enormous amount of energy in this country. The production of electrical energy by means of the latter process is already carried on a scale so great that it represents a new group of industries capitalized into the millions. But even these accomplishments are small in comparison to what may be expected in the near future when the gas engines of small and large units are distributed throughout the iron and steel sections of the country in sufficient numbers to meet the demand.

It has been generally claimed that so valuable is the waste blast furnace gases considered when burnt in the gas engines that the production of pig iron will become of only secondary importance. That is, the blast furnace plant will be far more useful and profitable in producing electrical energy for manufacturing purposes than it has been in the past in making pig iron. If a plant producing 150 tons of pig iron furnishes 21 million cubic feet of gas per day, it is quite apparent to all that as a gas generator it certainly is a remarkable plant. This enormous amount of gas was formerly little used. It represented waste energy which could not be satisfactorily harnessed. Blast furnace gas is very poor compared with commercial gas manufactured for city uses. Its average is less than 28 calories per cubic foot. It did not seem possible that this gas could be utilized in any sort of engine. Consequently the only part of the waste gas reclaimed was that used for heating the air-blast of the furnace. This to some extent introduced economy in the manufacturing of pig iron.

The waste gas has been used to some extent to heat the boilers of steam engines, but only very ineffectually. To illustrate the difference between the two, if the 21 million cubic feet of waste gas is employed to heat the boilers of steam engines not more than 2,000 effective horsepowers could be obtained thereby; but when burnt in the gas engine about 7,000 horse-power can be produced. Where about one-half the waste furnace gas is used for heating the airblast for the furnace there is still left a sufficient volume to produce 3,500 effective horse-power by means of the gas engine.

Fuel saving by means of the economizer is still employed in many plants. and more attention is given annually to the waste flue gases of an ordinary mill or factory. In such an ordinary furnace it is estimated that the pound of coal when burnt to evaporate nine pounds of water will at the same time release twenty-one pounds of fuel gas. This gas escapes up the flue, and must either be reclaimed or used to heat the water in the economizer. When the gas goes up the flue its temperature is about 600 degrees, but it is reduced in the economizer to about onehalf or 300 degrees. In losing half of its temperature the total amount of

gas from the pound of coal gives up 1.512 British thermal units. If this amount of heat could be utilized directly for heating the water it would be found that the nine pounds of water could be raised to a temperature of sixty-eight degrees. This all presupposes a perfect burning apparatus, and also the utilization of every heat unit from each pound of gas. But the fact is we seldom can reach such perfection. In practical operation we can rarely save more than 1,200 of the 1,512 heat units released. If we accept the value of the coal to be 13,000 British thermal units, this would be a saving of 9.4 per cent.

Another method of reclaiming the escaping gases in an ordinary flue is to use them for preheating the air before it is admitted to the fire. This method has proved economical in many mills where every heat unit is of some special value. The high temperature of the gases in the flue are reduced in this way from 600 degrees to 250, and even to 150 degrees. The air itself which it is desirable to heat before entering the furnace is brought up to a temperature of 140 degrees by this method.

For the combustion of one pound of coal there is required twenty pounds of air. When this air is preheated before entering the furnace it will absorb 900 heat units from the hot gases of the flue. In this process it practically saves 7.4 per cent of the heat of the coal.

These two methods of economizing in fuel in the ordinary plant presupposes mechanical devices for driving the air blast so that the highest efficiency can be obtained. With forced draught of this nature the height of the chimney must be considerable. In plants where the feed water is heated by the exhaust steam, the use of the flue gas for preheating the air-blast adds greatly to the efficiency of the plant, and saves fuel sufficient to pay for the extra cost of the appliances in a short time. Another consideration to be remembered is the character of the feed water of the boiler. If this is full of impurities which will endanger the life of the economizer by depositing sediment and foreign substances in the tubes, it is unwise to resort to this method of heating the water unless some mechanical means can be employed for purifying it. This is not always possible where the water contains large quantities of sulphur and other dissolved impurities. The use of the flue gases for preheating the air-blast is then more economical, and the employment of the exhaust steam for heating the feed water.

In all these different methods of economizing fuel by utilizing the waste gas for heating the feed water, perheating the air-blast for the furnace, or burning the gas in gas engines for generating electric power for transmission or for local auxiliary purposes, the fact is kept steadily in mind that we are gradually extracting from each pound of coal a larger percentage of heat units than ever before. The ultimate object must always be to save as many of the heat units unlocked from each pound of coal as modern mechanical appliances will permit. The method of accomplishing this end must radically differ in different plants. So much depends upon the size of the plant and surrounding conditions and circum-

stances that it would be difficult to establish more than general rules.

To the electrical engineer the utilization of the waste blast furnace gases for the generation of electrical power seems the most fascinating, for here is something which directly shows visible results on a large scale. The saving of a part of the heat units of the pound of coal in the ordinary steam plant employed for driving an electrical generator is not always so apparent. It takes a little study and figuring to prove it. The coal pile may not seem to diminish quite so rapidly, but it must be a long time before a large saving can be figured out. This is further less attractive because the initial installment of the auxiliary machinery stands warningly before the mind. In fact the installation of the economizers cost in investment from $10 to $13 per horsepower, allowing for attention to it, and the machinery for preheating the air-blast from $8.50 to $10, according to the size of the plant. It is not easy to induce the owner of a plant to make such investments unless the saving is absolute and clear.

The utilization of the blast-furnace gases in the gas engine on the other hand is a most apparent saving, and one that appeals to all. Here the engine is burning what was formerly waste, and the power generated represents absolute gain. It is much like operating a machine by means of air or water. There is no fuel pile, no cartage or handling. After the apparatus is once installed for reclaiming the gas, cleansing it of impurities, and carrying it to the gas engine, the work is complete, and the gain evident to the engineer or owner as he daily watches the generation of the electrical power. The application of the gas engine to burning the waste gases of the blast furnaces is consequently building up in the iron and steel regions of Pennsylvania electrical industries second only to those on the line of the Niagara current.

Pneumatic Tubes in Boston

By E. D. Sabine.

THE Pneumatic Tube as a carrier of telegrams and single letters has been in use in England and Europe for many years. As a system for carrying messages and as a substitute for cash boys in our large stores and office buildings, it is a familiar object in the United States. However it was only ten years ago that the Post Office Department of the United States adopted this system for the quicker transportation of mails. During the winter of 1892-93 there was laid in Philadelphia, a line of six inch cast iron pipes bored out on the inside and connected with unique machinery for the handling of the carriers. Four years later this system was extended in Philadelphia and introduced into New York and Boston. The new lines however were eight inches in diameter, more than doubling the capacity of the system. In 1900 and 1901, a ten inch system was laid in Boston. This was originally intended for parcel delivery, but in the fall of

1902, the Government rented it for Post Office use.

This is the largest system that has ever been in practical operation. The headquarters are in the building at the corner of Essex and Chauncey Streets directly at the head of Harrison Avenue, where a station of the Boston Post Office has been established. From here one line of tubes runs to the Back Bay Post Office, and another to the Roxbury Post Office and the South End Post Office on Washington Street.

The ten inch system differs from all

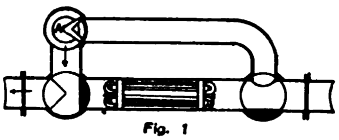


Fig. 1

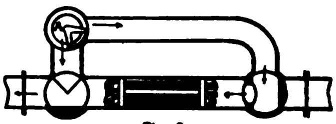


Fig. 2.

others now in use in many respects. The carrier, which is the life of the system, is a departure from all existing forms. It consists of a cylindrical shell, 30 inches long, which is supported by a cast steel head at either end. These heads carry five pairs of lugs which support small drop forged steel wheels. These wheels are placed radially and are staggered so that those at one end do not follow in the track of those at the other. The carrier normally runs on two wheels at one end and one at the other, the extra wheels serving merely as guides, until the carrier changes direction or turns over a little when they in turn do the heavy work.

A door opening the full length gives access to the interior of the carrier. The capacity of a ten inch carrier is about a thousand letters as against six hundred for an eight inch, and two hundred and fifty for a six inch.

The tube through which the carrier runs is of cast iron pipe similar in design to ordinary water pipe. The bell end is counter-bored and the spigot turned so that a close fit is obtained at each joint, without shoulders or other obstructions. In casting the pipe special care was observed to secure a smooth surface inside, free from lumps and of nearly uniform diameter.

In laying the pipe an iron mandrel was passed through each joint in order to make certain of a perfect fit.

The tube was laid in a trench varying in depth according to the obstructions encountered in the street. Every piece of pipe was blocked from the undisturbed earth and wedged firmly into place. The joint was then tested with the mandrel and if satisfactory made up with lead as in water pipe. The joint was again tested and then another pipe set. In back filling, selected gravel well tamped was used to cover the pipe, and the excavated material was placed on that.

The bends are of cast iron, elliptical in cross section, and of twelve feet radius. These were used at street corners and in the buildings.

The terminals are of an entirely new design, radically differing from those used on the preceding systems. The receiver consists of a tee, compression chamber, and valves and cylinder to operate it. The air pumped in at the other end of the line passes through the tube underground to the receiver. There it turns down

through the tee to a tank, from which the compressor at the end of the line draws its supply of air. This tank is open to the atmosphere and provided with racks on which calcium chloride can be placed to dry the air in wet weather. This prevents condensation in the tube and keeps the line dry. A carrier driven along by the current of air, comes to the receiver and passes through the tee into the compression chamber. Here it is brought nearly to rest by the compression of the air in front of it. It is found that in any line the carrier will roll to the same point of the receiver, whatever its load; but in different lines having different grades, etc., the point may not be the same. This point having been found by experiment, the receiver is adjusted to operate when the carrier reaches it.

The operation of the machine consists simply in opening the valve at the end of the compression chamber by means of compressed air in a cylinder. The carrier rolls out and as it clears the valve, the slight pressure of air behind it causes two vanes to spread apart and operate an auxiliary valve that causes the cylinder to close the main valve on the machine. The whole cycle takes less than five seconds.

The transmitter or sending machine is more complicated, as an entirely different problem is presented. The air at the beginning of its journey through the tube is at a pressure of some pounds above normal. This pressure is used in overcoming the friction of the air against the walls of the tube. To introduce the carrier into the current of air without interrupting its flow, some form of air lock must be used.

The method used is illustrated in the accompanying diagram which shows the principal valves.

The compressors used were built by the Rand Drill Company and are of the belt driven duplex type, with cylinders of twenty-four inch diameter and twelve inch stroke. They run at a hundred and fifty revolutions per minute. Both inlet and outlet valves are of the Corliss type, insuring high efficiency and smooth running. The normal running pressure varies with the length of line but is approximately three pounds. This gives the carriers an average velocity of thirty miles an hour.

The compressors are driven by five hundred and fifty volt three-phase induction motors of the internal resistance type. These motors were selected on account of their high efficiency under overload and their freedom from complicated parts.

The absence of commutator and brushes was a strong point in their favor. They have stood the strain of two years' running wonderfully well, there having been but one instance when the line has been shut down on account of trouble with the motor, and that was due to the carelessness of the operator.—*"The Tufts Engineer."*

An apprentice course of instruction for draftsmen has been established by the General Electric Company at the Schenectady works. It is under the charge of Mr. J. W. Upp, and is intended to qualify applicants for work in the drafting rooms of the company.

Hook for Iron Breakers.

NEARLY every foundry uses scrap iron to mix with the pig in the cupola and the scrap must be reduced to handling size.

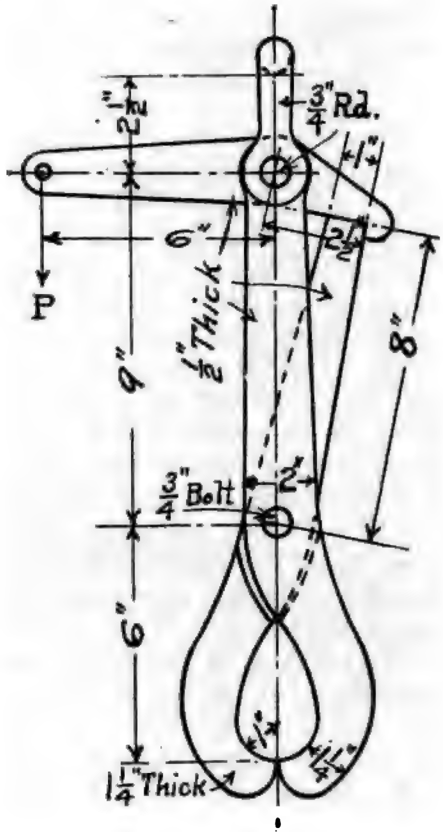
For this purpose, a breaker is erected, which in appearance resembles a well derrick with its windlass.

The illustration only shows the design of the hook for engaging the lift rope with the weight or breaker.

The weight may be of any shape from that of a sphere to that of a style used for driving piles. A weight of 500 to 600, with a lift of 25′ will do effective work.

To find the size of a casting ball to weigh 500 lbs, divide 500 by .26 which gives the cubic inches in the sphere = 1923.08. The volume of the sphere is equal .5236 d^3, then dividing 1923.08 by .5236 will have d^3 = 3672.8.

Extracting the cube root of 3672.8. we have 15.4″, which is the diameter of the sphere.

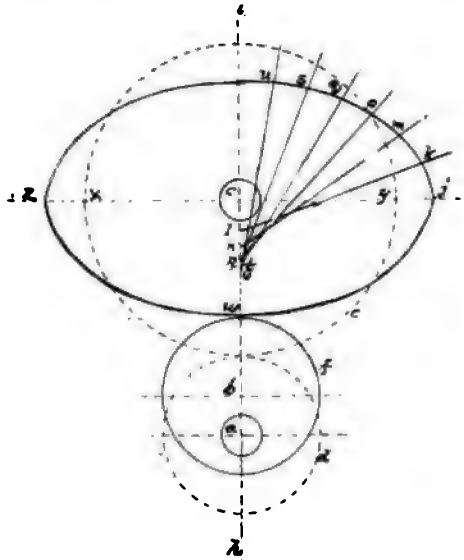


Elliptic Gear.

BY R. W. J. STUART.

I HAVE just had an experience in gear pattern making that is out of the ordinary, the case being a two-lobe elliptic driving a circular gear set on the shaft eccentric. Of course this method could only be applied where the eccentric or small gear revolved twice to the elliptic or large gear once. When this job came up, I was rather loath to undertake it, as I had made circular gears only heretofore, and upon inquiring among all the nearby pattern makers, I found that not one of them had ever done just such a job. Fig. 1 will give an idea of what the gears were like, and how I got about solving them. First I took the center a and c on which the gears were to run, and drew the pitch lines as they would be if both gears were concentric, then from the center b, I drew the pitch of the small gear as required in the pattern. The next operation was to draw the ellipse.

The points x and y being the two foci, and the points at which to stick pins for drawing the ellipse with a string. I tried the string but found that I could not get the ellipse as true as I wanted to, owing to the stretch in the string, so in order to get it right, I made the train shown in Fig. 2 of cigar boxes. The distance from y to j and from x to y being equal to ab, Fig. 1. Therefore, in setting the tramel the distance from the tracing point to the nearest guide block center should be equal to wc and from



the tracing point to the farthest guide block center equal to cj. The ellipse drawn, lay out pitch points, then to get the proper slant for the center lines of the teeth, set one leg of the dividers in the center c and the other in the tooth center j. With the radius dj, set in tooth center k, marking off the point l on the line wc. Join l and k, extending the line out beyond the pitch point k. With the same radius set at m, marking off p, m, n, o, q and so on. Set train and draw root and point lines. Lay off thickness of teeth on pitch, root and point line. Set the dividers for a radius equal to 1½ times the pitch and draw in faces and flanks. Our gear being elliptic, in-

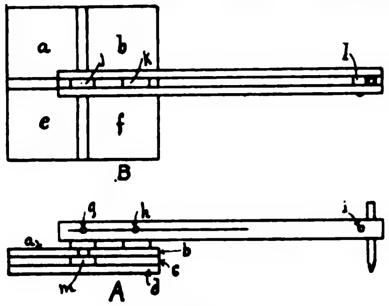


Fig 2

stead of circular and the teeth slanting, we will have to find the center with dividers for each individual tooth face and flank, so that the lines will pass through the points set off.

The patterns I made were for a heavy, coarse pitch, slow moving gears. I was surprised they worked so nicely. I have found that with coarse pitch gears, I can build up a blank and saw out the teeth on the band saw, setting the table, bevelling for draft having only to smooth them by hand. I believe the train may be used to transmit a limited amount of power, in which case it would take the place of gears of large diameter.

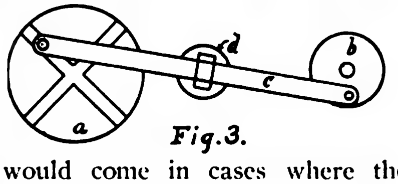


Fig.3.

It would come in cases where the shafting are too far apart to use gears, and it is desired that one shaft turn in an opposite direction to the other, and make double the number of revolutions.

Drafting Wrinkles.

THERE are many little schemes that the draftsman of any experience runs across in his labors, and the following may be new to some of your readers.

They are simple, yet practical for every day use, what one wants.

How many times on a large piece of work have you been annoyed at the tee-square sliding onto the floor and probably throwing it out of adjustment thereby. If you are ever troubled in this manner, just fasten a small piece of rubber, slightly thicker than the blade of the tee-square, on the lower part of your board near the left edge, say 2″ in and ½″ up from edges. This will prove an effectual stop for the square, Fig. 1.

When taking a dimension off your metal scale, if you use one, how much quicker you could work if the divider or compass needle would stay where you wished it on the scale, instead of slipping off "just as you have it." Take a prick punch and make a slight dot at the extreme right hand mark on the scale both sides. See Fig. 2. When by placing the point in this slight impression, you have no fear of losing the place.

Again, how often could you save that penful of ink by passing it into the compass leg or other instrument. By opening the blades somewhat of the former and holding it over the closed blades of the latter, the ink will rapidly run from one to the other as shown in Fig. 3. Try it.

Another simple scheme for tilting the tee-square just enough for ruling screw threads, Fig. 4, is to cut a piece of wood as shown, to the angle desired and when in use is held in place by the fingers.

These little things are used by some of the best designers I know and are worth trying. DESIGNER.

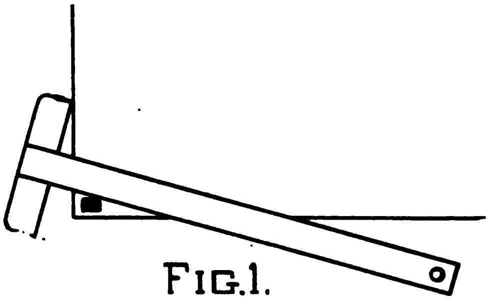


FIG. 1.

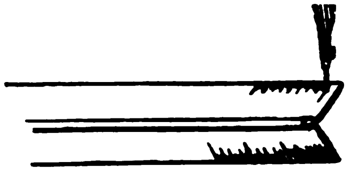


FIG. 2.

FIG. 3.

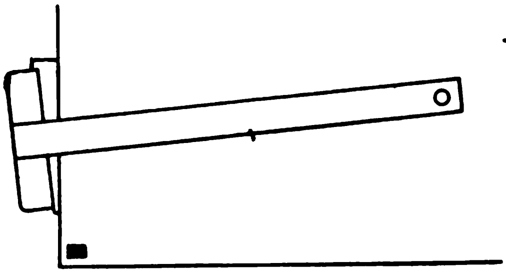


FIG. 4.

The Tangent Circles.

Editor THE DRAFTSMAN.

Dear Sir: In the January number of THE DRAFTSMAN Mr. H. MacDonald gives a method of describing a circle tangent to three other circles. This is similar to a query which appeared a few years ago in one of the mechanical papers except that a formula was asked for finding the center of the circle; no one offered a solution.

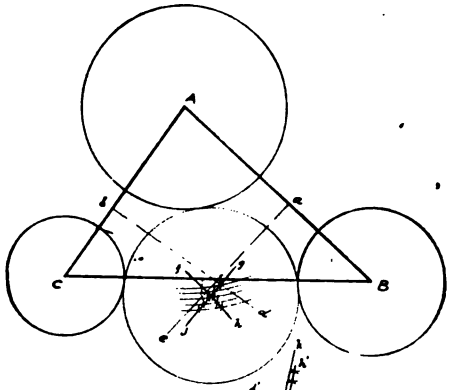


FIG 2

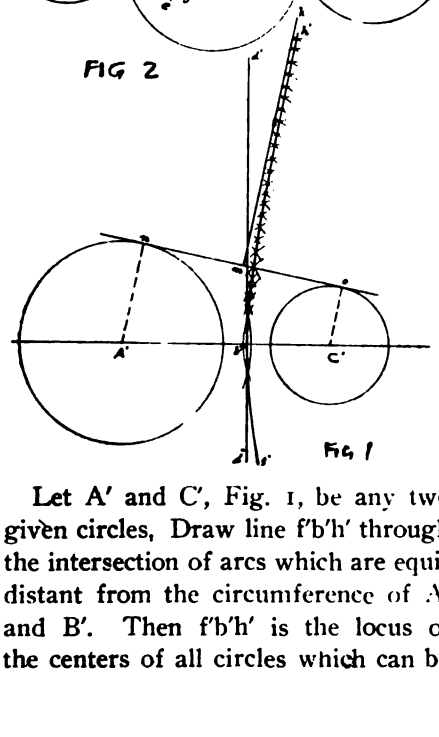


FIG 1

Let A′ and C′, Fig. 1, be any two given circles, Draw line f′b′h′ through the intersection of arcs which are equidistant from the circumference of A′ and B′. Then f′b′h′ is the locus of the centers of all circles which can be drawn tangent to A′ and C′. If continued this line would be tangent at infinity to the line "mk" drawn perpendicular to the tangent "no" of the two circles at its center "m." Where it crosses the line of centers A′C′ it is tangent the perpendicular d″d′ drawn at the point b′ half way between the two circumferences A′ and C′. To return to our problem, let ABC, Fig. 2, be the three given circles tangent to which we are to draw another circle. If we take two pairs of the circles and find the locus for each pair similar to Fig. 1, the intersection of the two loci will be the center of the required circle. It is not necessary to draw all of the line; only a short distance each side of the required center is all that is needed. Erect the two perpendiculars "ae" and "bd" at the middle points of the distances between the circles on the lines connecting the centers of the circles. Then the intersection "ae" and "bd" will be near to the required point. Then describing arcs equidistant from the given circles and drawing lines "gj" and "fh" through their intersections we find the center of the required circle at the point where the three cross. The solution given by Mr. MacDonald is not strictly correct, its accuracy depending on the relative sizes of the three given circles and also on the distance of these points "c" and "d" from "D." His solution gives the intersection of the tangents drawn to the two loci and the nearer the points of tangency are to the required point "D" the more nearly correct the solution will be. Also if the difference in size of the

given circles is very great, the locus has very sharp curve at the beginning, so that in this case if his points "c" and "d" are some distance from "D," the circle can not be drawn tangent to the three given circles.

Yours truly,
F. W. SEIDENSTICKER.

Letter from a Draftsman.

Editor DRAFTSMAN: Noticing in your March number Mr. MacLean's construction of "To describe a circle tangent to three given circles whose

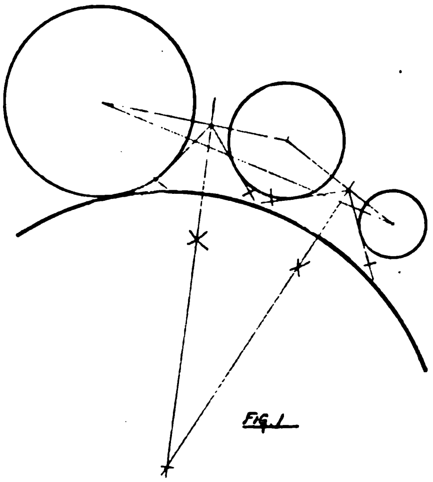


FIG. 1

diameters are different, would say that while it would apply in some cases, its range of usefulness would be more limited than in the first construction.

For illustration, in Fig. 1 it will be seen that if circles happen in position shown, said construction would not work out as accurately as in first which is fairly illustrated in Fig. 2.

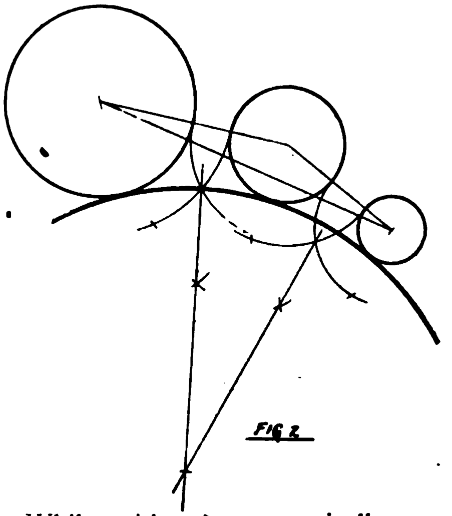


FIG. 2

While neither is geometrically correct, they serve very well for laying out on a drawing to approximate the center.

H. MACDONALD.

Machine Design.

EUGENE HIGGINS.

OFTENTIMES in designing machines and their details, it is impossible to compute the stresses in them. When a large and small machine have been carefully designed or built, the sizes of the details in machines of immediate capacities may be found by the formula d, = $fc^{n} + i$ in which d, = the required dimension of a detail in the new machine.

c = the size or capacity of the new machine.

f = the factor.

i = the increment.

In the following formulas:

D and d = the dimensions of de-

tails in a large and small machine.

C and c = the sizes or capacities of a large and small machine

Let d, = fc, + i (1)

d = fc + i (2)

D = fC + i (3)

Transposing (2) i = d — fc (4)

Transposing (3) i = D — fC (5)

Equating (4) and (5) d — fc = D — fC (6)

Transposing fC — fc = D — d (7)

Combining f(C—c) = D —d (8)

Transposing f = (9)

As an illustration of the above, it

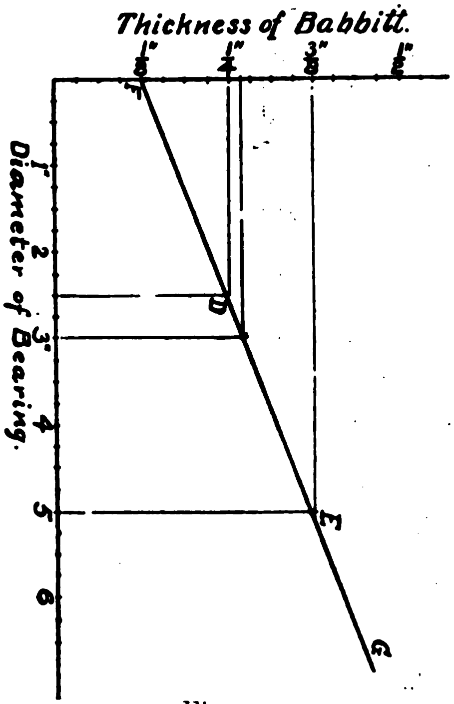


Fig. 1.

may be found from practice that the thickness of babbitt in a 5" bearing should be 3/8" and that in a 2½" bearing, it should be ¼" thick. What should be the thickness of babbitt in a 3" bearing?

In this case C = 5", c = 2½", D = 3/8" and d ¼". The factor may be found from (9)

$$f = \frac{D-d}{C=c} = \frac{\frac{3}{8}-\frac{1}{4}}{5\text{-}5\frac{1}{2}} = \frac{\frac{1}{8}}{2\frac{1}{2}} = \frac{\frac{1}{8}}{5\text{-}2} = \frac{2}{40} = \frac{1}{20}$$

The increment may be found from (5)

$$i = C - fC = \tfrac{3}{8} - \tfrac{1}{20} \times 5 = \tfrac{3}{8} - \tfrac{5}{20} = \tfrac{3}{8} - \tfrac{1}{4} = \tfrac{1}{8}''.$$

To find the thickness of babbitt of a 3" bearing, formula (1) may now be used.

$$d_1 = fc_1 \times i = \tfrac{1}{20} \times 3 + \tfrac{1}{8} = \tfrac{3}{20} + \tfrac{1}{8} = \frac{24+20}{160} = \frac{44}{160} = \frac{11}{40} = .275, \text{ say } \frac{9''}{32}$$

As f and i have been determined for the thickness of babbitt in bearings, formula (1) may be written $d, = \frac{c, + 1}{20 \quad 8}$ in which d, is the thickness of babbitt required and C, is the diameter of the shaft. All dimensions in inches. The problem may also be solved by the graphic method as shown in Fig. 1. Take a sheet of CUT No. 392.) cross section paper and lay off the diameters of the shafts on a horizontal line as "AB." Lay off the thickness of babbitt on a vertical line as "AC." The points "D" and "E" are at the intersection of the lines representing the diameters of the bearings and the corresponding thicknesses of babbitt.

Through these points, draw the straight line "F" "G."

Upon inspecting the diagram, the thickness of babbitt for any diameter of shaft may be readily found, as for instance, the thickness should be nearly $\frac{9''}{32}$ for a 3" shaft.

Subscribers Wanted in every drafting room and factory.

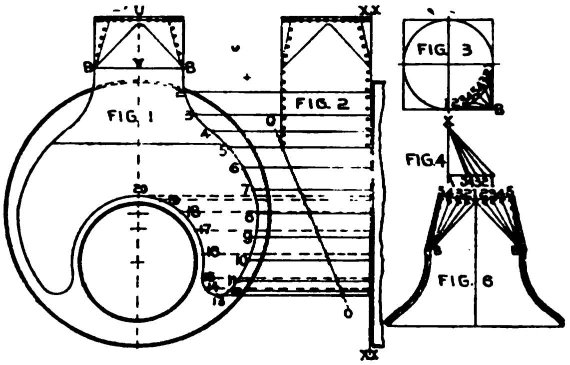
A Breeching for a Scotch Boiler.

THE accompanying sketch shows a common form of breeching used in connection with the Scotch type of boiler and will no doubt be a good lesson for the students, or young men in the trade, who desire to become familiar with laying out of breechings. This is an excellent lesson, for the reason that the curve changes at nearly every point.

TO LAY OUT SUCH A BREECHING.

First strike up the diagrams, Figs. 1 and 2, and as the breeching is narrower at the bottom than at the top, set at the same spacing as they were set when you divided up the circle or curves around the breeching, set off the same number of parts in Fig. 5 and number them the same from B to 20. You will note that all points were located about 4 inches apart, but at the bottom sharp curve they are spaced closer, or in other words, 2 inches apart, as this is necessary in all sharp curves if you are desirous of producing a perfect curve when sheet is rolled up and bent to shape.

Having located the lines on Fig. 5



strike the bevel line O-O, Fig. 2, which represents the line of cut-off. Now, starting at point B, Fig. 1, set your dividers about 2 inches apart, so that you will not lose by going around short curves, and mark the points 4 inches apart as denoted by points 2, 3, 4, etc., to 20. After these points are established, extend lines from these points over to the back line of breeching, which will be noted by X X, and X X. Please note that we have drawn dotted lines from the inner circle and solid ones from the outer curve, Fig. 1, so that you can readily distinguish the difference in the points of cut-off in Fig. 2. Now, with your dividers from B to 20, using the back edge of breeching as A-B, extend the dotted lines across the plate of an indefinite length. In this case we are going to make the outside wrapper of the breeching in two pieces and will locate the seam at 20, as this is the most convenient place for it on account of rolling and working the plate.

Now take a strip of light band iron and lay on dotted line 20 and set one end on line X X, Fig. 2, then mark the point where the slope line O-O strikes line 20 and carry this measurement over to Fig. 5 and mark this distance from A to 20. Now take the strip back to Fig. 2 and take the length of

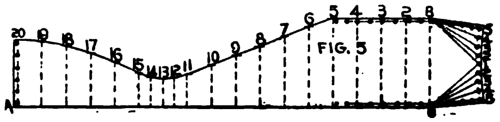
all the dotted lines from X X, X X, to O-O, as 19, 18, 17, 16, 15 and 14, and transfer these measurements to Fig. 5 from line A. B. Mark off point 19, 18, 17, 16, 15 and 14 and lines drawn through these points will give the curve of the inner circle.

Now take the strip back to Fig. 2 and lay it on the solid lines from line X X, X X, and mark all the points for the outside curve as 13, 12, 11, 10, 9, 8, 7, 6 and 5; then transfer them to Fig. 5. Then a line drawn through these points will give the required curve. As the breeching is straight from point 5 to B, no measurements are necessary other than the circumference of the circle from 5 to B, Fig. 5, which you have already placed upon the plate when your dividers were set.

The top of the breeching is round, as shown in Fig. 3, and at line B-B, Fig. 1, it is square, as will also be seen in Fig. 3. The top is laid out just the same as in any piece—square on one end and round on the other.

TO LAY OUT THE TOP.

First strike up the diagram, Fig. 3, and divide one quarter of the circle into any number of parts, as in this case 8 as shown, and numbered 1, 2, 3, 4, 5, 4, 3, 2 and 1. As the base of this is square, only one-eight of the circle is necessary, but to make it plain I have divided the quarter as shown. To get the triangles necessary to lay out the curve on the top of the breeching: First, get the perpendicular height in Fig. 1 from V to U, and mark this distance from A to X, Fig. 4; then lay down a base line any length at right angle with line A-X. Now, with tram points set from B to 1, Fig. 3, carry this measurement to Fig. 4 and with A as center, strike an arc at 1. Now take the distance from B to 2, Fig. 3, and with one point set at A, Fig. 4; strike another arc at 2; then take the distance from B to 3, Fig. 3, and from A, Fig. 4, mark off point 3. Then go back to Fig. 3 and get the distance from B to 4 and transfer to Fig. 4. Next get the length of line B to 5, Fig. 3, and mark off a corresponding distance from A to 5, Fig. 4. Now run these lines from 5, 4, 3, 2 and 1 to X, and the necessary triangles are complete. By these triangles the top of the breeching will be laid out. Now the question may arise, why is it necessary to strike up Fig. 4? The answer is that we get two measurements—first the perpendicular height, and second the measurements at the bottom line, showing how far away from the corner B the different points on the circle arc. With this explanation we will proceed to lay out the top of the breeching.



Now set your tram points from A to 1, Fig. 4, and with B-B, Fig. 5, as centers, strike the arcs at 1, thus producing the center hole at top. Now, with dividers set for the spaces around the circle in Fig. 3, with 1 as center, Fig. 5, strike an arc each side of the center as at 2-2. Now go back to Fig. 4 and get the distance from A to 2, and with

one end of tram points set at B and B, Fig. 5, strike an arc at 2 and 2 each side of the center, to cut the arcs just struck from point 1. Then with dividers set as before, and with 2 and 2 as centers, strike an arc at 3 and 3. Now go back to Fig 4 again and get the distance from A to 3 and from B-B, Fig. 5, strike the arcs to cut those just struck at 3 and 3. Now get the distance A-4 and A-5 from Fig. 4 and transfer to Fig. 5, using the dividers as set for the spaces and produce the points 4 and 5. Now draw the curve line through these points and the line for the rivet holes will be complete. Now lay down the line of rivet holes along the sides and locate the rivet holes, and Fig. 5 will be complete.

The upper end of Fig. 6 is laid out the same way, except the points B and B in Fig. 5 are placed at the outside corner on the sheet, while in Fig. 6 they are located on the corner of the flange line as shown. The lower part of Fig. 6 is simply a reproduction of that part of Fig. 1 below the line B-B, with the necessary lap added for rivets and flange. The seams are located on the quarter, as this is the most convenient place for same, as the work is gotten out with but very little waste.—*Motive Power.*

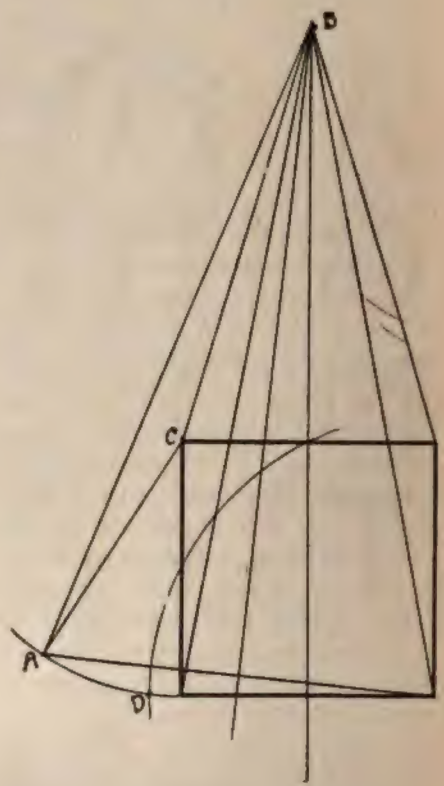
Editor DRAFTSMAN: Your article by Mr. Arthur B. Babbitt in the December number of THE DRAFTSMAN entitled "Something for Our Geometrical Friends," was a very interesting problem.

Referring to the accompanying sketch, I would answer his question, "Where is the trouble?" by saying that line AB does not in any case cross inside the corner of "C" of the square.

By using point "D" instead of "A", as Mr. Babbitt shows, point "B" would be infinitely high or at least high enough to still keep line "AB" outside of corner "C."

Proving this would blot out the problem entirely.

H. MACDONALD.



ARCHITECTURAL.

Architectural Lettering.

A DESCRIPTION OF VARIOUS LETTER FORMS SPECIALLY ADAPTED FOR THE PRACTICAL USE OF THE DRAFTSMAN ON PLANS, WORKING DRAWINGS,

PRACTICALLY all the lettering now used in architectural offices in this country is derived, however remotely it may seem in some cases, from the old Roman capitals as developed and defined during the period of the Italian Renaissance. These Renaissance forms should be studied first at a large size in order to appre-

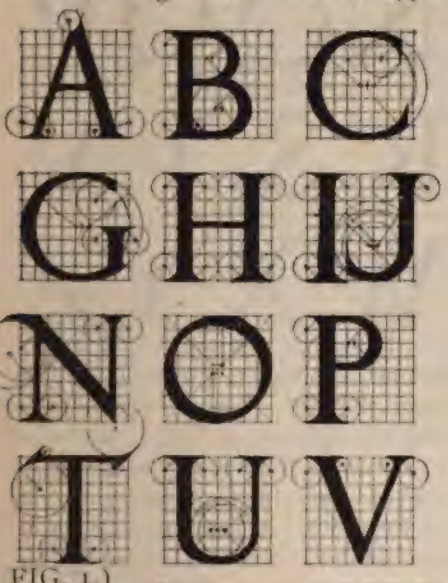


FIG. 1.)

ciate properly the beauty and the subtlety of their individual proportions. For this purpose it is well to draw out at rather a large scale—four or four and one-half inches in height—a set of these letters of some recognized standard form; and in order to insure an approximately correct result some such method of construction as that shown in Figs. 1 and 2 should be followed. This alphabet, a product of the Renaissance, though of German origin, is one adapted from the well known letters devised by Albrecht Dürer about 1525, and is here

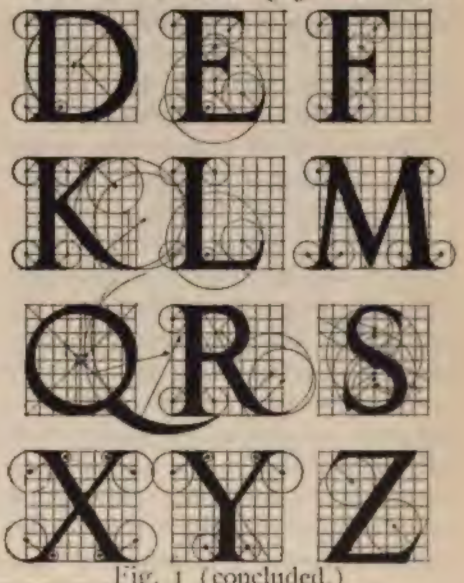


Fig. 1 (concluded.)

merely redrawn to a simpler constructive method and arranged in a more condensed fashion. This may be accepted as a good general form of Roman capital letter in outline, although it lacks a little of the Italian delicacy

the two sloping faces used to define the letter. An example is shown in Fig. 7, taken from drawings for a building by McKim, Mead & White, the same convention being frankly employed to emphasize the principal lettering of a pen-drawn title.

For the purpose of devising a letter that may be drawn with one stroke of the pen, and at the same time retain the general character of the larger, more Classic alphabet, in order that it may be consistently used for less important lettering on the same drawing, it is interesting to try the

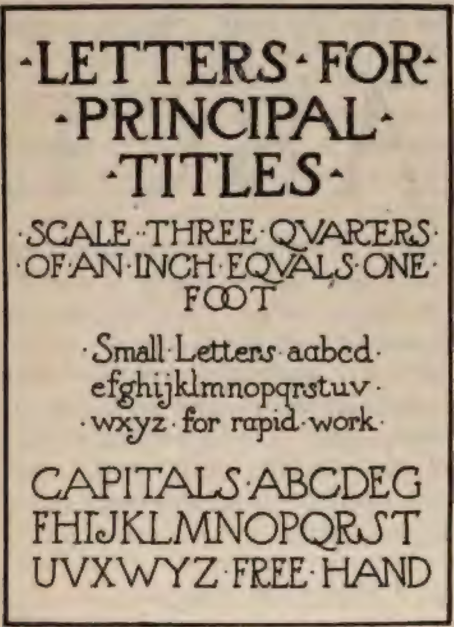


Fig. 9.

experiment of making a skeleton of the letters in Figs. 1 and 2. his consists in running a single heavy line around in the middle of the strokes that form the outline of these letters. This "skeleton" letter, with a few modifications, will be found to make the best possible capital letter for rapid use on working drawings, etc., and in a larger size it may be used to advantage for titling details. It will also prove to be singularly effective for principal lettering on plans, to give names of rooms, etc., while in a still smaller size it may sometimes be used for notes, although a minuscule or lower-case letter will be found more generally useful for this purpose.

In Fig. 6 are shown four letters where the skeleton has been drawn within the outline of the more Classic form. It is unnecessary to continue this experiment at greater length, as the idea is sufficiently developed in these four letters. In addition, it is merely the theoretical part of the experiment that it is desirable to impress upon the draftsman. In practice it will be found advisable to make certain further variations from this "skeleton" in order to obtain the most pleasing effect possible with a single-line letter. But the basic relationship of these two forms will amply indicate the propriety of using them in combination or upon the same drawing.

It will be found that the letter more fully shown in Fig. 9 is almost the same as the letter produced by this "skeleton" method, except that it is more condensed. That is, the letters are narrower for their height and a little freer or easier in treatment. This means that they can be drawn more rapidly and occupy less space, and also that they will produce a more felicitous effect.

In actual practice, the free capitals shown in Fig. 9 will be found to be of the shape that can be made most rapidly and easily, and this style or some similar letter should be studied

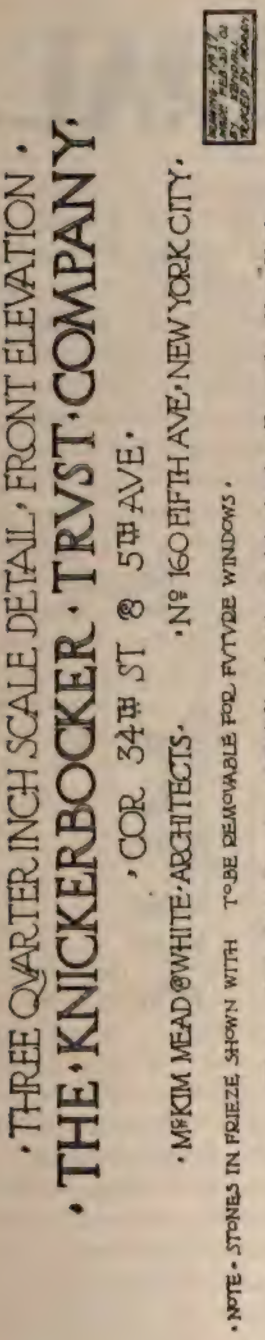


Fig. 7. Title from Drawing of Building for the Knickerbocker Trust Co., New York. McKim, Mead & White, Architects.

and practiced very carefully.

Other examples of similar one-line capitals will be found used with Classic outline or blacked-in capitals on drawings, Figs. 3, 5, and 7. In Fig. 8, this one-line letter is used for a principal title as well, and with good effect.

In Fig. 9 is shown a complete alphabet of this single-line letter, and also an excellent form of small letter that may be used with any of these capitals. It is quite as plain as any Engineer's letter, is easier to make, and, when correctly placed upon the drawing, is much more decorative. Fig. 9 represents the actual letter shapes that are used on architectural drawings. As they are so valuable to draftsmen, they should always be at hand for instant use.—"*The Technical World.*"

NEW COURT HOUSE.

The new court house of Cuyahoga County, in which Cleveland, O., is situated, it not to cost more than $3,000,000 and the content not to be more than 6,000,000 cubic feet.

The supervising architects figured several times before they could cut the price to $3,000,000, but now they promise to double their force of draftsmen and get the revised plans out so to get the work ready for the foundations next fall.

The cost of furnishing the building, paying the architects and other expenses will be about $1,500,000, for the architects will get 5 per cent. of $3,000,000, making $150,000 as the amount of their fee.

sive use. Sections 3 and 4 show heavy columns combining Z's with plates and channels. Section 5 shows a combination of two Z-bars with one I-beam.

examples of building construction. The relative advantages of these standard sections are obviously of importance in influencing a choice, but that any particular type can be selected as

(1) (2) (3) (4) (5)

Fig. 3.

the best for universal application is manifestly impossible; selection must be made to fit the particular requirements and in keeping with the ideas and opinions of the designer.—*Ryerson's Monthly.*

The foregoing examples will serve to show the great number of forms offered the designer from which a selection may be made; nearly all of them are to be found in prominent

Misleading Information.

THE writer has in his possession several catalogs, which under the head of useful information give the safe distributed loads for steel I beams. In some instances, mention is made that the safe concentrated load is one-half that of the concentrated load, while in others, it is completely ignored; in none of them is mention made of that limiting value of medium and long beams, namely the lateral deflection.

The result is that occasionally some one not versed in I beam lore uses this information in its literal sense, and is much surprised later to see the beam fail under a much less load than the tabulated one. It does not seem to be generally known outside of those directly engaged in structural designing that I beams which are not supported laterally usually fail laterally unless the beam is quite short. It seems to the writer that publications which, for instance will tell the public that a 12" 31½ lb. beam with 30' span is safe for a center load of 6400 lbs., without mentioning that the beam should be sufficiently braced laterally, is spreading misleading information which might easily cost human life and financial loss.

I know of one instance in which failure occurred in a beam selected from catalog information and several more in which it was mere good fortune that it did not occur, the beams having a factor of safety of about two.

It is to be generally regretted that this condition exists, as there are a class of men who use this free information literally and whose faith in it is unbounded because it is in print.

HOME STUDY.

The Helix.

IF a point moves in two directions about a line as an axis, that is, around and in the same direction as the line, at the same time, a *helical* curve results.

A simple form of this curve is found in a common spring and the lines which bound the threads of screws.

The line of a winding stairway is a helix and is not a *spiral* stairway as is so commonly called.

The motion of the point in its different directions may be uniform or variable but in the common forms of the curve both motions are uniform and are produced by a point which moves uniformly around and along a cylinder at the same time.

The distance which the point travels along the cylinder, in going once around it, is called the *pitch*, which is the same amount that the nut on a bolt moves when the latter is turned through one revolution.

To draw a common helix, divide the circle which is the top view of the cylinder into any even number of equal parts and divide the pitch into the same number of equal parts as in Fig. 1.

When the point has moved upon the circle of the top view over one of the equal parts, it has moved in the front view along the axis a distance equal to one of the equal parts of the pitch A to 1. When it has moved one quarter around the circle, it has moved one quarter of the pitch and so on for the whole revolution of the

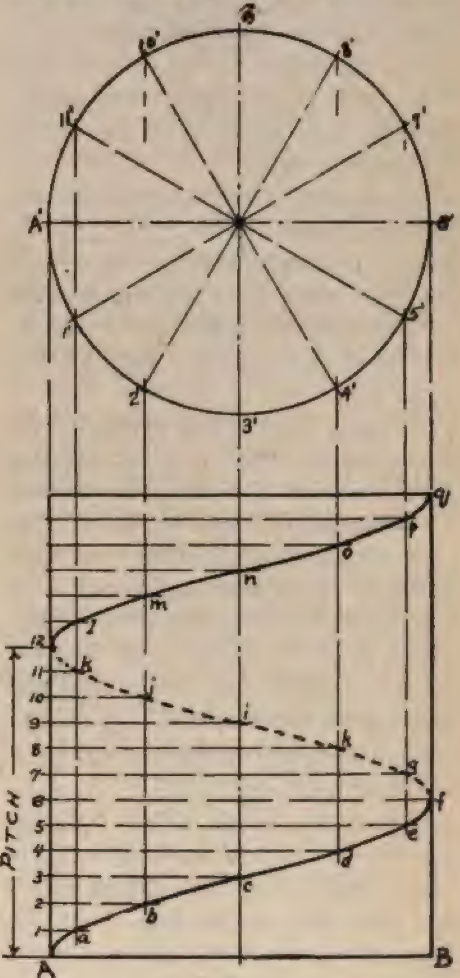
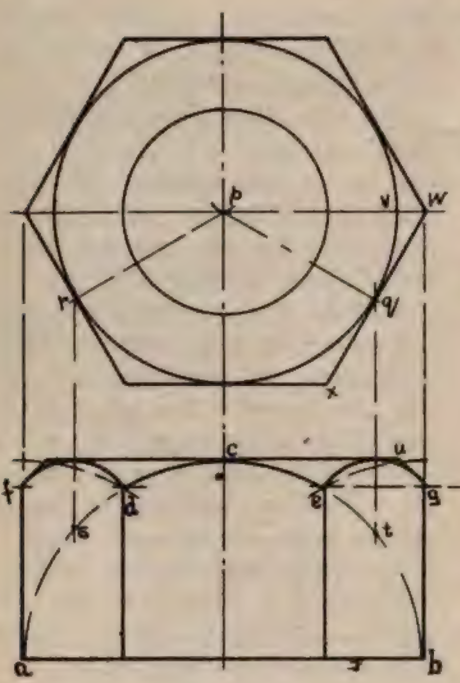


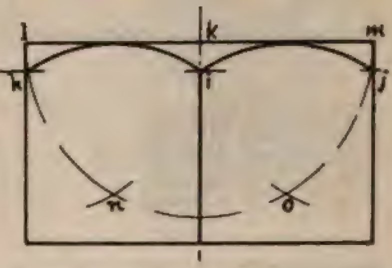
Fig. 1.

Hence to obtain all the points for generating point.
the front view of the helix, draw par-



a radius pz, draw arc lnom and with l and m as centers, cut arcs at no and o, which are the centers for the arcs hi and ij.

The straight lines in the top view are made by means of the tee-square and 30° triangle.



Elementary Course in Mechanical Drawing

(Continued from April Issue.)

PLATE XVIII.

Problem I.

Draw a helical curve on a cylinder 2½" in diameter with a pitch of 2". The center of the circle is to be 2½" from the left border line and 1¾" from the top border and the front elevation to be ¼" from the circle and 3" long. Lay out the curve as explained for Fig. 1.

Problem II.

Draw a helical flange as shown in Fig 2 with the length of cylinder and large circle the same as in Fig. 1

The diameter of the inner circle to be one-half the large one.

Let the base of the circle be ½" from the bottom border line and place the top view near the front view.

Problem III.

Draw the section and half top view of a nut for a 3" bolt with V threads. The front view is to show an elevation and part section of the screw and a section of the nut.

The points in the thread lines are found as in Fig. 2, by dividing the circles in the top view and the pitch into the same number of parts.

The nut should be 5" long, 2½" wide in the top view and 2½" thick in the front.

Locate the center line of Fig. 3 7¼" from the left border line and the top view is to be 1¼" from the top border and the top of the nut in the front view to be 5¾" from the top bor line also.

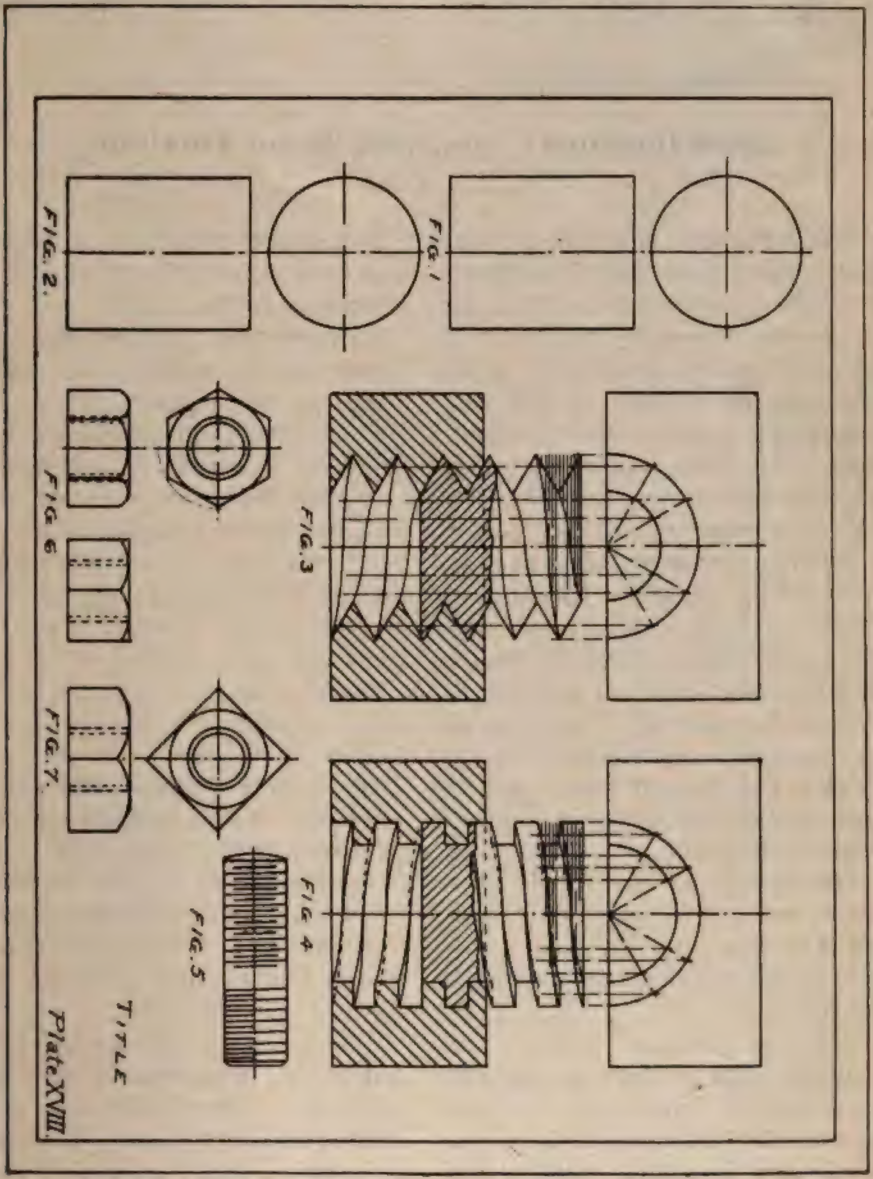
Draw the section and half view of a nut for a 3″ bolt with square threads.

Locate the center line of Fig. 4, 3¾″ from the right border line and the views are to be arranged on a line with those in Fig. 3.

Problem V.

Draw a 1″ stud 3½″ long and represent the threads by two convenient methods.

Locate its center line 3½″ above the bottom border line and let its right end be on a line with Fig. 4 as shown.



Problem VI.

Draw three views of a hexagon nut for a 1″ bolt by means of one of the

methods described above.

The center of top view to be 3" above the bottom border and 3" from the center of Fig. 2. Center of side view to be $1\frac{1}{2}$" from the center of the front view.

Problem VII.

Draw two views of a square nut for a 1" bolt by means of one of the methods given above.

The center lines of the top view on a line with that of Fig. 6 and 6" from the right border line.

Some Questions Answered by an Amateur.

A pattern-maker must first consider the amount of use that the patterns are likely to serve, whether they are for standard or special machines, and the quality of the castings, so far as affected by the patterns. A first-class pattern may cost twice as much as another, yet a cheap one will do almost as well where there are but few moulds to form.

Patterns may be parted so as to be "rammed up" on fallow boards or a level floor, or they may be solid, and have to be bedded; pieces on the top may be made loose, or fastened so they can be taken off. They may be well finished so as to draw clean, or rough so that the mould may require a great deal of time to dress up after a pattern is removed.

The expense of patterns is often greatly reduced by the use of cores, but is in some cases increased.

A certain allowance must be made for shrinkage.

For most purposes, patterns are made of wood, but in heavy parts of machinery, such as pulleys and gear wheels, iron patterns are best. As there must always be more or less loose sand in a casting, it is important to arrange the pattern so that this part will come in the least disadvantageous position.

The pattern-maker uses a drawing to get the shape of the object, and the dimensions of the same.

A shrink-rule is a rule used by a pattern-maker, providing for shrinkage of the metal while cooling.

A core box is a divisible box in which clay is rammed to form cores.

A core print is a projecting piece on a pattern for moulding to form a hole in the mould to receive the end of the core by which it is sustained in the mould in proper position, relative to the object cast.

Draft in this sense is the slight tape given to patterns to aid in removing them from the sand.

Dry sand is a mixture of sand and loam which is used in making moulds, subsequently dried in an oven.

The cope is the top side of mould.

The drag is the lower part of mould.

A flash is a frame or box which holds a portion of the mould for casting.

The moulds for castings are of several kinds. A pen mould into which the metal is poured, the upper surface of the fluid metal assuming a horizontal position, such as ingots. Close moulds of sand are those in which articles of iron, brass, bronze, etc., are made.

CURRENT TOPICS.

A slight difference in colors on the cover was made in the March issue of THE DRAFTSMAN, but it made a better appearance.

A certain draftsman has a notice in the "Want Column" of "Miscellaneous Data on Brickwork." It is miscellaneous but it is worth many times the price asked and no draftsman should be without this kind of information, so he may be prepared to figure this class of work.

THE DRAFTSMAN has subscribers in Alaska, China, Australia, New Zealand, Hawaii Islands, Mexico, Chili, Cuba, Spain, England, Canada, and recent inquiries have been had from India.

A certain magazine announces that with its increased equipment for producing a better periodical, it will no doubt raise the subscription price, but if $2.00 be sent at once, the name would be entered for the length of the life of the subscriber. This means 20 years at the present price and the magazine is worth the price.

Another magazine offers to keep the name on their list for five years for the sum of $3.00. If any one will send $3.00, we will send THE DRAFTSMAN for five years. We will endeavor to be liberal, too. THE DRAFTSMAN is gaining strength each month.

The Metric System.

In *The American Machinist* is seen two items following each other.

1st. "The House of Lords has passed unanimously the bill making the use of the metric system compulsory in Great Britain after April 5, 1906."

2nd. "At a hearing of the House Committee on Coinage, Weights and Measures, held March 10, Mr. L. D. Burlingame, chief draftsman of the Brown & Sharpe Manufacturing Co., presented in the name of the company, a protest against the passage of the pending bill."

So we are to stand still for a while or rather to go along in the same old rut with the same old weights and measures that are a blot on the name of civilization and advancement. It is to be hoped that the bill will be passed and the people given a certain time to prepare themselves for the new system.

Among the names recently added to our subscription list is one from Chili, South America.

A Notice, but a Good One.

The following notice appeared recently in a well known drafting room:

"Gentlemen: Of late there has been a general laxity about observing the rules of this office. Some rules in

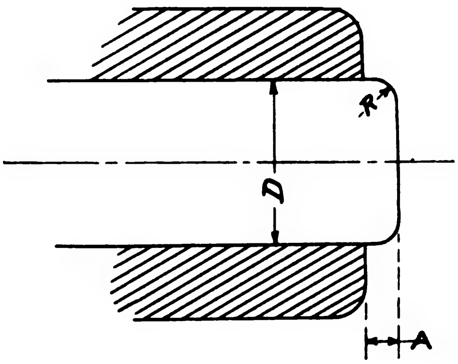
business should be understood and must be here. General conversation during business hours is prohibited, as is whistling, humming, drumming on the desk or any other unnecessary and distracting noise.. You must stay at your boards, except when necessary to interview each other about the work in hand, then talking must be in a low voice. The hour for beginning work is 7:30 a. m. sharp. I find a number of you do take advantage of my absence from the room to indulge in a general conversation and rough house. I will not tolerate this and the first one who shows a disposition to continue under the old regime may expect to *be fired.* You are here to work, that is all. Respectfully,

"———."

Corners for Projecting Shafts.

ENCLOSED you will find a sketch and table, giving good proportions for corners of projecting shafts,

Possibly this may be or some service to you in filling up some empty corner of THE DRAFTSMAN.



D	A	R
$\frac{1}{4}$ – $\frac{7}{16}$	$\frac{1}{32}$	.03
$\frac{1}{2}$ – $\frac{9}{16}$	$\frac{1}{16}$	.04
$\frac{5}{8}$ – $\frac{11}{16}$	$\frac{1}{16}$	.05
$\frac{3}{4}$ – $\frac{13}{16}$	$\frac{1}{16}$	.06
$\frac{7}{8}$ – $\frac{15}{16}$	$\frac{3}{32}$	.07
1 – 1$\frac{3}{16}$	$\frac{3}{32}$	.08
1$\frac{1}{4}$ – 1$\frac{7}{16}$	$\frac{3}{32}$	$\frac{3}{32}$
1$\frac{1}{2}$ – 1$\frac{15}{16}$	$\frac{1}{8}$	$\frac{1}{8}$
2 – 2$\frac{7}{16}$	$\frac{3}{16}$	$\frac{5}{32}$
2$\frac{1}{2}$ ——	$\frac{3}{16}$	$\frac{3}{16}$

THE DRAFTSMAN, in its new cover and enlarged size, is surely a decided improvement, and this is simply a reflection of what is found within. It should appeal to all men who call themselves draftsmen.

Sincerely yours,

ARTHUR B. BABBITT.

Some Valuable Hints for the Drafting Office.

BY HENRY C. HAMMACK.

MANY schemes have been introduced and used for designating tracings, but we find that the one universally adopted is that whereby each tracing is given a number. Mostly the numbers are taken in consecutive order from one up, and if a new tracing is made, no matter what part the

tracing may be made to show, whether a cylinder or boiler, no exceptions will be taken, but the new tracing will be given the next number in the series which has not yet been used. While there is no question but what the method of giving each tracing a number, and each new tracing the next number in the consecutive series, is far better than the old method of keeping track of your tracings by using the names of the different parts to designate same, yet we will ask the question, "What method have you of grouping the numbers of any particular subject so that they will really become self-indexed? The answer to this question would undoubtedly be "Not any." Then if not, why not! This is a point that will be found that has not been looked after in many of our drafting offices, and if a method is employed it is usually undertaken, as stated before, by using subjects and

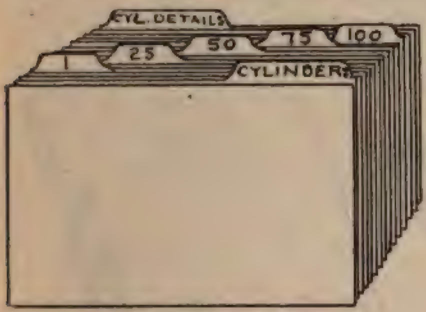


FIG. 1.

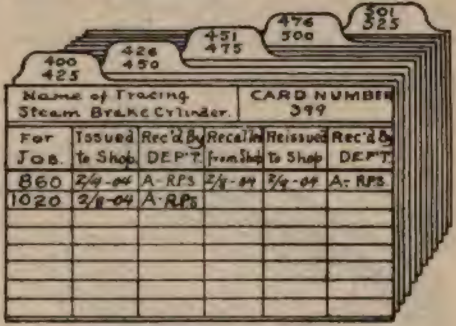


FIG. 5.

FIG. 2.

with this is connected a great amount of detail and unnecessary work. Of course, it is not the claim of the writer that the method described herein will be perfect by any means or that it cannot be improved upon, but it is claimed that the same will remedy this fault above mentioned and will materially aid in looking up tracings, either for reference or for the purpose of having new blue prints made from same for use in reference drawers, and will also tend to produce a self index.

In all modern drafting offices blue prints are used for reference instead of the original tracings, in order to save the wear and tear an the tracings as much as possible, hence what I mean by prints for reference drawers, are the prints used for this purpose.

Now, while I do not object to numbering tracings in consecutive order, yet the method of arranging an index will be found a much easier task if

some exceptions are taken in using the numbers. We will bring the card index into use, and will say that you use or reserve a certain series of numbers for certain subjects. For instance, say that you are manufacturing engines, boilers, etc. For cylinders and cylinder details, which will be classified under main head of cylinders, you would use numbers ranging from 1 up to 500. This depending on how many tracings of cylinders and details you would have to take care of. Then you could use for boiler tracings and numbers used in the first series which in the case of cylinders and cylinder details are numbers 1 to 500, the second series would be numbered like this: 1-2, 2-2, 3-2, etc., the figures representing the main numbers being twice the size of the figures designating the series. In this way the main numbers first allotted for cylinders and cylinder details would always remain the same, still there would be ample provision for increase, even if the figures used to designate the series would only run as high as 10, as it is

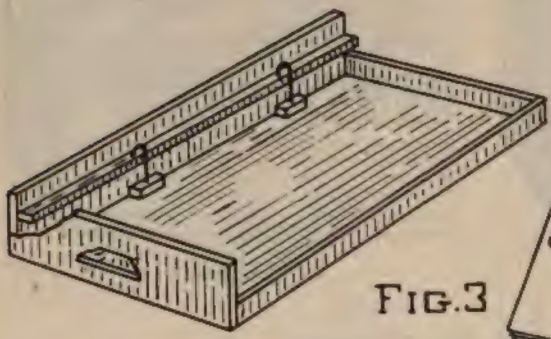


FIG. 3

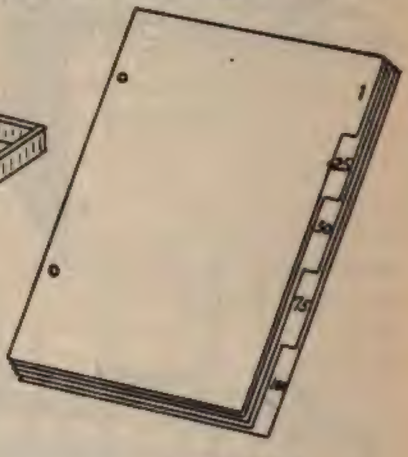


FIG. 4

boiler details numbers ranging from 500 to 1000, this also depending on the number you would have to take care of. Then, so on, running numbers up as high as would be required to meet your demands. Then in time, suppose you should use all the numbers allotted for any particular subject, to simplify matters and to refrain from using other new numbers, that is to say, suppose that numbers from 5000 up which would be available in allotting numbers to any new subject had not been used instead of using these numbers we would retain the main not likely that you would have more than one thousand tracings of any one particular subject. If it was desired the letters of the alphabet could be used to designate the series, instead of numbers.

Now, in arranging our card index we have two important points to look after, namely: Card numbers and names of tracings. The file suitable in which to place index cards showing tracing numbers or card numbers as they are above termed and other general information which you would desire to have on card, is shown in Fig.

1. The guide cards showing numbers being one-fifth cut and the guide cards showing names of tracings or parts of machinery being one-third cut. The guide cards showing numbers to be placed in index case with the tab at left hand side, running left to right and the guide card showing name of tracing at right hand side running right to left, or vice versa. In this way the guides showing numbers will not be confusing with guides showing names of tracings. Now, in going further into this, supposing numbers 1 to 100 in your series of 1 to 500 would be sufficient to carry tracings showing general plan of cylinders, then you would have available numbers from 100 to 500, or 400 numbers which could be used for cylinder details of the different cylinders. Then on the main guides in index you could show something like this: "CYLINDER DETAILS," then you could subdivide the different details under cylinders so they could be easily turned to without running over all cards under details if you were looking for any particular part. What I mean by sub-divide is to have Guide Cards showing each detail separate. As an example, have Guide Cards showing Valve Stems, Valve Stem Stuffing Box, Piston Rod, Links, Link Blocks, etc. Then, for instance, all cards for links of all size cylinders will be found, following the Sub-Guide Card "Links." In doing this it will also be necessary to sub-divide your numbers. To explain this, will say that the first Sub-Guide Card under CYLINDER DETAILS would be Cylinder Heads; then you would allot so many numbers to cylinder heads just as the requirements would demand. In all cases you should group your numbers, say, in sets of ten, twenty-five, fifty, seventy-five or one hundred. That is, in the case of cylinder heads, the first number in your series would be 101, and if cylinder heads would require 100 numbers, your Guide Cards would show like this: 101, 125, 150, 175, 201. If the case would happen to be that you would only require twenty numbers, then Guide Cards would show like this: 101, 110, 121. We arrange it in this way for the reason that if you should be looking for a cylinder head knowing the number to be 105 you would know at a glance at your Guide Cards that this number would be found in index cards between 101 and 110.

As it would be advisable to classify or arrange your cards in your Index Case so you could pick out a card for a certain size cylinder or certain detail part for any certain size cylinder without looking over all the cards under cylinders, I would suggest that the index cards used to carry the card numbers or tracing numbers (as they could be called) of the cylinder and other information, have a little tab on it. See Fig. 2. Then we could use as a cross index to designate the different size cylinders, the stroke in inches, and supposing cylinders are of the following sizes: 8 x 8, 8 x 10, 8 x 12, etc. On this small tab on card you would place 8, 10 or 12 just as the case may be. Then, say you wanted to find card for an 8 x 10 cylinder, you would run down over the tabs in your index and find a tab which would have 10 on it, pick it out and you

would have the card before you giving information relative to 8 x 10 cylinder together with tracing or card number, without regard to card number. Supposing that you had several size cylinders, the stroke being 10 inches, that is to say, you would have cylinders 5 x 10, 6 x 10, 8 x 10, 10 x 10, etc. In this event you would put on the small tab both the diameter of the cylinder and the stroke. As an example, will say that you have a 6 x 10 cylinder, you would put on the small tab 6-10, therefore showing at a glance the card in your index which has the tracing number and other information that you may desire in regard to this size cylinder. This same cross index can be used in designating cards showing tracing numbers for different cylinder detail parts.

If you were building boilers and would designate the size of same by horsepower and you had boiler tracings of 10, 20, 30, 40 and 50 H. P. boilers, the general plan tracings could be given the first numbers in your series, same as in the above described case of cylinders and boiler details could be given the numbers following. Then the cards giving tracings numbers of the various H. H. boiler general plan tracings could show on the small tabs, as a means of cross index, the H. P. of the boilers, which could be 10, 20, 30, 40 and 50, and under details the same scheme could be used.

It appears to me that no matter what you are manufacturing, there is hardly any question but what you could use a system along the same line as above outlined, unless it would be in the foundry business, or a business where you were building machines, all of which are exactly duplicate of each other.

Now, in connection with the method of indexing your tracings and blue prints used as reference, I have a scheme for placing tracings or blue prints in the drawers in your case. There has been a great many methods employed; some use tubes and roll the tracings, others use envelopes, and some lay the tracings in the drawers loose, but I think I have a method which is equal to all. If you roll tracings that makes them hard to handle, and if you put them in envelopes there is always considerable time consumed and then the tracing will almost always turn up at the corners or double when putting same back in the envelope. If you lay them in loose and have, say, a hundred blue prints or tracings in one drawer, they are almost certain to get mixed up, and when you go to look for a certain print or tracing it will be found necessary to look over the entire number of prints or tracings in the drawer before you find the one you are looking for. My method is simply to use a file inside of the drawer, made along the same order as a letter file. I show my idea in Figs. 3 and 4. From this you can get a very good understanding of how it is arranged. Of course it is better to make the drawer or tray, as it may be called, same as shown in cut Fig. 3, that is, make the right side of the drawer and the rear end only about 1½" high, but if your case was made you could use the file in ordinary drawer or tray. The little curved rods can be made of ¼" spring steel wire, and then simply bore a hole in the block at the bottom of the

drawer to receive the lower end of the rod and another hole in the strip running across the drawer near the top, to receive the other end. Have the holes bored a little snug and have the rods tapered at each end so they will fit in tight, but not so tight but what they can be removed when desired. Cardboard or binder-board divisions can be made of rather light weight card or binder board with two holes punched in same to receive the rods which holds same in place. Then the idea is, that if you have 100 tracings in one drawer, there would be four divisions and 25 tracings in each division. See Fig. 4. In this way, suppose you wanted Tracing Card No. 87, you would know that it would be in division 75 to 100. You could turn to this division and pick it out in almost a second, and then, after you had used the tracing it would only be a simple matter to replace it in the drawer in the proper division and its proper place in the division. It would also be more apt to be replaced in its proper place by using this method than if other methods are employed.

Another suggestion I have to offer is a method of keeping track of what cards you have in the shop. Of course, in a small shop this could probably be kept in a small memorandum book, but when you have from 500 to 1,000 cards in the shop at a time it becomes burdensome to keep track of same in this manner. The Card Index again comes into play. Of course, it is supposed that the tracings are all numbered as above outlined, and all prints issued in the shop are mounted on heavy binder board, and generally speaking are only known by card numbers. Then the style index card which I would suggest using is shown in Fig. 5. Now these cards are filed in a card index file case containing Numerical Guide Cards, same as shown in Fig. 5, the numbers on the guides running as high as the numbers of tracings you may have. Then, when a card is issued to the shop, one of these index cards is filled out and sent with the card to the department askin for it, and the card is receipted for either by the foreman or his clerk. Then the index card is sent back to the drafting room to be filed in the file case. When the shop is through with the card it is either sent back or recalled by the drafting room and filed away in racks made for that purpose to be held in readiness for another job which would take the same card. In some plants it may be that some of the cards would stay out in the shop until they are worn out before they are recalled. One of the advantages of having this record is that when you do a class of work where duplicate orders are frequent, the same cards being used for several different jobs, the drafting department can tell at a glance at this record whether certain cards are in the shop, and if so it is only a matter of recalling the cards and entering the new order number on same. There is also oftentimes requests made by the foremen of the different departments to the drafting department for cards for certain parts, stating they had never been received by them. Now, without this Index to rely upon, the drafting department would have no definite proof that the particular print asked for had been issued to the shop, and they would simply have to

get out another print, have it mounted on a card and send it out. While this would not make so much difference in case the original card had not been changed to meet a request of the purchaser, yet if it should happen that the original card had been changed, which change would not be regular and would not show on the original tracing, you could quickly see the trouble it would cause. It sometimes happens that changes are desired to be made, and when foreman is requested to return the original card in order to make this change he will say that it cannot be located and that new card would have to be issued. Therefore, the drafting department would go ahead and get out new card and send it out in the shop, and in the meantime the foreman would locate the old card or original card and in some way get the cards mixed and go ahead and build the machine according to the original card. When the machine is sent out the customer would come back and say that it was not satisfactory by reason of certain changes not having been made as requested. You would endeavor to trace the trouble, and the foreman would produce the original card and state that he built the machine according to prints he had to work by. You would then take the matter up with the drafting department and would find that change was requested to have been made, but apparently they had not made the change on the card. Now, according to the circumstances the change was made and proper card issued to the shop, but the foreman used the wrong card. However, from the fact that no record was kept of the transaction, the drafting department would be held responsible for the error, while the fault was with the foreman. If this system is used nothing of this nature would occur, as on your index card record would be made of the new card having been issued to the shop, and if a mistake of this kind would occur it could be traced to the proper department. With such a system it will be found that it will not only aid the drafting department to keep their record clear on such points, but it will tend to make the foremen more careful of the cards issued to them and entrusted in their care.

An Electro-Photographic Printing Press.

BY FRANK C. PERKINS.

While much has been done in recent years in the improvement of printing apparatus for ordinary type work, and electric motors are extensively employed to great advantage, little or nothing has been accomplished in the way of rapid machine photographic printing from negatives until recently. Mr. Fred P. Stevens, recently of Colorado Springs, well known from his famous "Sunrise" and "Sunset" pictures of Pike's Peak, has invented an automatic electric printing machine which will turn out a thousand prints per hour. The accompanying illustrations show the arrangement of the arc lamps and the printing frames as well as an exposition print from this electric press.

The operation to an observer is

identical to that of a foot-power printing press, the paper being fed in a sheet at a time by the right hand and removed by the left. The principal difference is that the pressure back that forces the paper into contact with the negative is brought down by the hand immediately after placing a sheet of paper in the frame, instead of automatically as in a printing press. But as it opens automatically when the exposure is shut off and as the speed of printing is about the same, the likeness is striking.

The machine facilitates job work and variation in the size of the negatives, their printing quality and the number of prints required makes no differences in the ease with which the machine is operated. For large manufacturing plants the photograph is being more and more extensively used in illustrating apparatus. Electrical machines, machine tools, turbines, engines, and in fact every form of manufactured article is now photographed in the shop, and when installed for filing and for illustrated article, magazine and catalog work. The wholesale printing from negatives in the old way is tedious and expensive. The electric printing machine will fill a long felt want.

One actual performance of the first machine built was the turning out of 1,250 4 x 5 prints from 75 negatives by a young lady operator in two hours and 45 minutes. Only one person was developing these prints or the output would have been doubled. A gross of amateur work can easily be printed from different negatives in 20 minutes. It is stated that the electro-photographic machine at St. Louis Exposition has printed with ease a gross of 8 x 10 prints in 19 minutes, losing only four prints from incorrect exposure.

Where several hundred prints are required from a negative the average speed of production is from 7 to 12 minutes to the gross, in regular practice, according to the size of the prints and the density of the negatives. After a little experience an operator does uniform work on negatives that require not over a quarter to a half second exposure. Ninety-five per cent. of the negatives in commercial work are exposed by the machine in less than a second. The exposure is controlled by the operator's foot working a treadle which is swung forward naturally from the knee, opening shutters of orange fabric which return to their normal position by the action of a spring when the pressure of the foot is released.

The electric light is a 500-candle

power enclosed arc in a reflecting box lined with asbestos and painted white. The printing press counter gives a record of the exact number of impressions.

Instrument for the Construction of Equivalent Geometrical Figures.

JEREMY C. WILLMON.

LOS ANGELES, California, has invented new and useful improvements in instruments for the construction of equivalent geometric figures. This invention relates to an instrument by means of which a square may be constructed whose area shall equal that of any given circle; also, by means of which a circle may be constructed the area of which shall equal any given square; also, by means of which a straight line may be drawn equal to the circumference of any given circle; also, by means of which a circle may be drawn whose circumference shall equal any given straight line; and the object thereof is to provide an instrument which will accomplish the above purposes without arithmetical calculation. He accomplishes this object by means of the instrument described herein and illustrated in the accompanying drawings, in which—

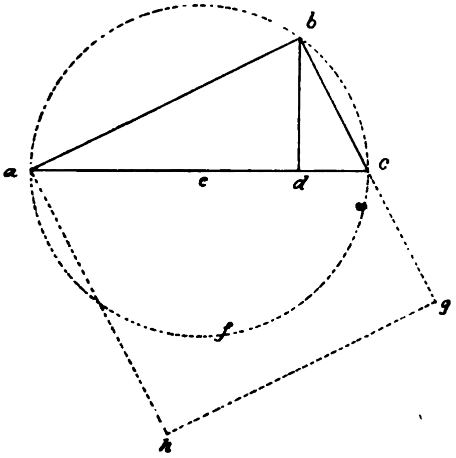
Figure 1 is a diagrammatic view of the formation of the essential angle of my instrument, with a circle and square shown in dotted lines. Fig. 2 is a side elevation showing a triangle embodying my invention.

In the drawings, A represents my complete triangle embodying my said invention and is formed in the following manner: Construct any circle—say the circle *a b c f*, having its center at *e*—then draw the line *a c*, forming the diameter of the circle. With *a* as a starting-point measure off on the diameter a distance equal to one-fourth part of the circumference which will terminate at the point marked *d*. At the point *d* erect a perpendicular to the line *a c*. This This perpendicular line will intersect the circumference of the circle at *b*. Then draw the lines *a b* and *b c*, thereby forming the right-angle triangle *a b c*, which forms a triangle embodying my invention in which the line *a b* forms the greater cathetus and the line *b c* forms the lesser cathetus and by means of which a square may be constructed equal in area to any given circle, or a circle may be constructed equal to any given square, or a straight line may be drawn equal to the circumference of any given circle, or a circle may be drawn the circumference of which shall equal the length of any given line.

To construct a square whose area shall equal that of any given circle, take any given circle and draw the diameter *a c*. Place my triangle with the apex angle *b a c* at *a* and with one side resting on the diameter *a c*. Mark on the circumference the point at which the side opposite that resting on the diameter and which helps to form the apex angle or the prolongation of such line intersects the circumference, and from this point draw a line to *a*, and this line will form one side of the required square.

To construct a circle whose area shall equal that of any given square, take any square, say *a b g h*, place the apex angle of my triangle at any corner of the square, with one of the sides which form said angle on the side of the square and the other side

Fig. 1.



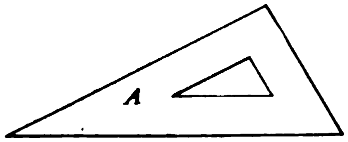


Fig. 2.

of the apex angle within or partly within the square, mark on the side of the square the point at which this last side or the prolongation thereof intersects the side of the square, and from this point draw a line to *a*, which forms the line *a c* and is the diameter of the required circle.

To draw a straight line equal to the circumference of a circle, take the triangle and place it upon the diameter of the circle with the point *a* resting on one end of the diameter and the base of hypotenuse *a c* resting upon the diameter, then prolong the line *a b* until it intersects the circumference of the circle. From this point draw a line to intersect the diameter and perpendicular thereto. The distance from the point at which this line intersects the diameter to the point *a* will be one-fourth the circumference of the circle and the same can be produced to the required distance.

To construct a circle whose circumference shall equal any given straight line, you will divide the line into four equal parts and lay the triangle upon the line with the hypotenuse resting thereon, with the point *a* at one of the ends thereof. Draw a perpendicular line from the point which is one-fourth of the distance from this end of this straight line. Draw a line along the greater cathetus to an intersection with this perpendicular line. This last line is bisected by a line at right angles thereto and the bisecting line extended to an intersection with the straight line. The point of intersection gives the center of the desired circle.

Proportional Dividers,

THIS invention relates to improvements in proportional dividers.

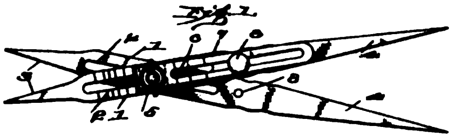
One object of this invention is to provide means by which the pivot-pin upon which the arms of the dividers swing may be securely held in its adjusted position, so that when the dividers have been once adjusted to any particular proportion there will be no danger of this adjustment being disturbed.

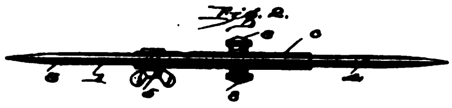
In the drawings, Figure 1 is a plan

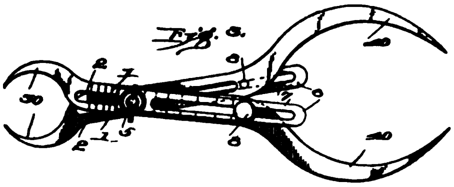
view of an ordinary proportional divider having my invention applied thereto. Fig. 2 is a side view of the same. Fig. 3 is a plan view of proportional calipers.

Corresponding parts in all the figures are denoted by the same reference characters.

In using proportional dividers of the ordinary style it is usually necessary to take a large series of measurements with the dividers adjusted to







the same proportion. In doing this it often happens that the position of the pivot-pin within the slot becomes shifted, thus destroying the former proportion between the different ends of the divider and sometimes causing serious trouble in carrying out the work then in hand. By the use of my improvement in proportional dividers the probability of such disturbance of the adjustment is very slight.

Referring to Fig. 1, in which a proportional divider having my invention attached thereto is shown in opened position, 1 1 represent two arms which in accordance with the usual construction are provided with the central slots 2 2. 3 3 represent the short arms or ends of the divider, and 4 4 the long ends or arms. Passing through the slot in each arm is a pivot-pin 5, which is provided with a suitable nut. Outside of each arm is a holding arm or bar 6, which is provided with an opening adapted to snugly receive the pivot-pin and a longitudinal slot 7. Passing through the slot 7 and screwing into the body of the arm 4 is a clamp-screw 8, which is provided with a head of such character that it may be readily engaged and turned by the hand. Two of these holding arms or bars are provided—one upon each arm of the divider. By this means the pivot-pin 5 is securely held in its adjusted position in each arm and the liability for displacement is very much lessened. At the same time the pivot-pin 5 may act as a clamp-pin, which further insures against displacement.

The calipers shown in Fig. 3 are constructed upon the same principle that is, are, in effect, the same instrument as shown in Fig. 1, except that the arms 30 30 and 40 40 are curved instead of being straight, as shown in Fig. 1. The surface of the arms of the calipers or divider may be provided with the usual scale indicating the proportions or relative sizes to which the device may be adjusted.

The inventor is Mr. Antonio Bosola, of New York City.

It is always better to start a good thing late, than not at all—it is, just get into the habit of reading "The Draftsman". If you get the habit we will send you "The Draftsman for five years for $3.00.

Summer School for Arrtisans.

The fourth annual sessions of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27th, and continues for a period of six weeks.

FREDERICK E. TURNEAURE,
Dean College of Engineeriing,
Madison, Wis.

Draftsmanship and Ingraving.

In view of the demand for freehand draftsmen in pen and ink line drawing which may be adapted to processes of engraving, Professor George Hartnell Bartlett, principal of the Normal Art School of Boston, has issued a practical book of instruction intended to lead ambitious students to help themselves.

The text includes eleven papers on line drawing, a brief history of the earlier arts of illustration and expositions of the processes of drawing and engraving on wood, steel and copper plate engraving, lithography, zincography, albertype process, zinc process, half-tone etching on copper and three-color process. It concludes with two readable essays on "Nature the Great Source of Inspiration for Composition" and "Art and Art Schools."

Professor Bartlett's instruction is first of all practical and to the point. He speaks with authority in clear English that may not be misunderstood. The histories of the early arts of engraving of the days of Durer and Holbein are pithy as well as interesting. A charming simplicity of diction leads the student to read facts and technical explanations which under other phraseology might be dry and uninstructive. A spirit of encouragement illuminates the lessons, while pertinent advice is given from the standpoint of generous criticism.

(H. O. Houghton & Co. · The Riverside Press, Cambridge, Mass.)

K & E Vertical Cylindrical Electrical Print Frame.

This cylindrical apparatus consists of two sections of curved glass, each mounted in a metal casing and together forming a cylinder which rotates on a circular base. It requires a floor space of about 36 x 42 inches. The lamp is suspended in the axial line of the cylinder, where it travels by clockwork with electric motive force.

Tracing and paper are placed on the outer surface of the glass cylinder, where they are held by a canvas curtain mounted on a vertical roller attached to the upright which carries also the lamp and the mechanism for moving it. This curtain is wound on to the cylinder by rotating the cylinder on its base, which is done by a conveniently placed handwheel. It is held tense by the roller spring and a foot brake on the base plate, which arrests the cylinder. The rotating of the cylinder therefore automatically winds the curtain on to it and holds the tracings and paper in very good contact. The feeding in of the tracing and paper is easily and quickly accomplished, and there is no tilting of the glass cylinder. The unwinding of the curtain is done by means

of the handwheel assisted by the spring acting on the curtain roller.

The lamp is of a special pattern to give perfect diffusion and distribution of light. It is moved by clockwork and can be set to any required speed, to any distance of travel, and to start from and stop at any point. The current is cut off automatically at the end of the travel of the lamp.

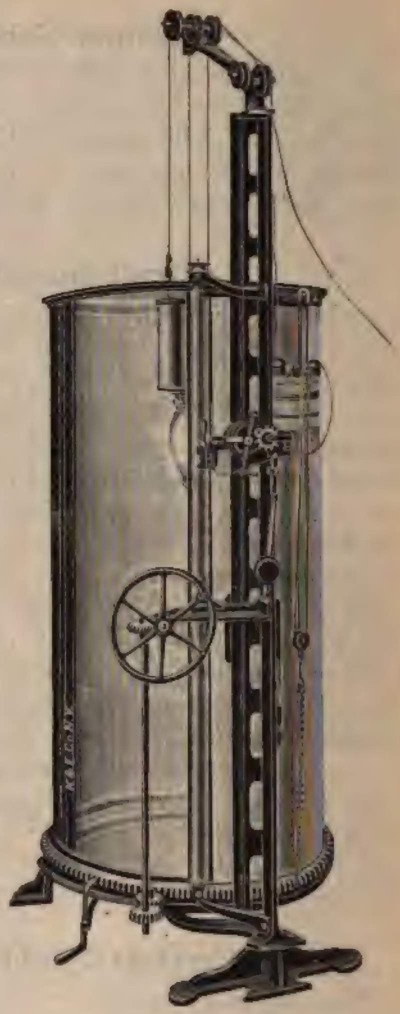
This is a very economical apparatus because it requires only one lamp, even for large tracings. Tracings and paper can be inserted and removed very quickly and conveniently. It is much less liable to accidental breakage than the similar cylinders which swing in pinions and are placed horizontal to load them. Besides they require less floor space.

These frames can be furnished with lamps for either direct or alternating current, 110 or 220 volts.

We furnish these frames all complete, ready to connect with the feed wire and can furnish them from stock at short notice.

KEUFFEL & ESSER CO.,

Drawing Materials, Surveying Instruments, Measuring Tapes. 127 Fulton St., New York.

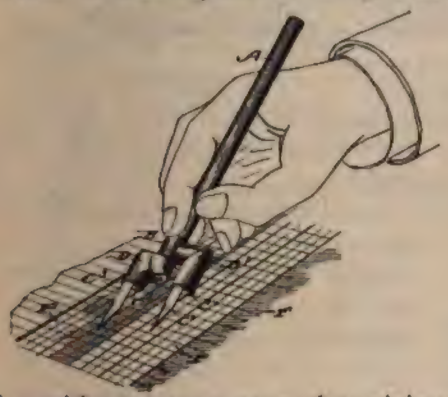


The Deepest Hole in the World.

The deepest boring yet made is at the village of Schladebach, near the line between Leipzig and Corbetha. It has been made by the Prussian government to test for the presence of coal, and was bored with diamond drills. Its depth is 1,390 metres (4,560 feet); its breadth at the bottom two inches, and at the top eleven inches. It has occupied three and a half years to bore, and cost a little over £5,000 sterling. The temperature at the bottom is 118 degrees Fahrenheit. —*Scientific American.*

An Improved Penholder.

R. R. B. McBEE, of Ardmore, Ind. Ter., has invented and patented a useful penholder which is an improvement on posting-pens, the object being a pen having a double point and adapted to simultaneously write duplicate columns of figures, and which is also capable of being used



in writing across a page, thus giving duplicate lines one below the other.

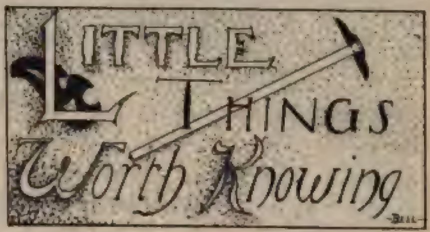
By placing a memoranda slip so that its edge will lie adjacent and parallel to the line on which the matter is to be written, a duplicate column of figures may be recorded.

DEATHS.

Mr. Edwin Horatio Fowler died at his residence, 1126 East Capitol St., after a brief illness. Mr. Fowler was chief draftsman of the United States Coast and Geodetic Survey, and had been identified with Washington life and affairs for more than a quarter of a century.

George Bryan, a draftsman in the employ of Harry Wachter, architect, died at St. Vincent's hospital after an illness of three weeks as the result of a complication of diseases. Mr. Bryan came to Toledo eight years ago, and since that time had worked for most of the architects here.

Harry Lindon, draftsman in the employ of the Reading Coal & Iron Co., died at Reading, Pa., having been struck by an engine.



To an electrician one horsepower is 746 watts.

The fiercest of all animals are the black panthers.

Two-thirds of the world's sugar is made from beets.

Of 1,200 locomotives in use in Japan, 500 are American made.

The largest oilship in the world, the Narragansett, has just been launched in the Clyde. She will hold 10,000 tons of oil, which can be discharged at the rate of 900 tons an hour.

There are 227 lead pencil factories in Germany, which employ 2,813 persons, and export each year 1,614 tons of pencils, worth $2,000,000.

Nearly all the safety matches which are safe against friction on sandpaper, stone, wood, or brick, ignite readily from a quick rub on glass.

Malta is the most thickly populated island in the world. It has 1,360 people to the square mile. Barbados has 1,054 people to the square mile.

World's Fair Facts.

The Holland submarine torpedo boat will navigate under the waters of the lagoons.

Nearly a hundred and fifty millions of feet of lumber were used in building this great World's Fair.

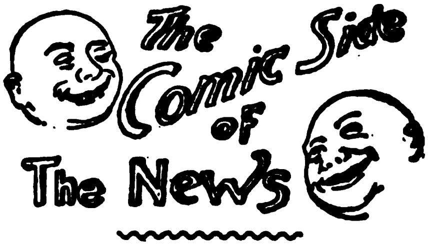
Among the kings who will visit the Exposition are: King Menelik, of Abyssinia; the King of Siam; Somdotoh Chowfa Moha Vagiravudh, Crown Prince of Siam, and Ibrahim, Sultan of Johore.

The foreign governments will be strongly represented. Germany and France are spending over $1,000,000 each; Brazil, $600,000; Great Britain, Mexico, China and Japan each over $500,000.

The Philippine exhibit covers forty acres, showing the commerce and industries of the islands. Includes native workmen and material, tribesmen, their families and huts, land and water vehicles, and a typical Manila street.

Five hundred thousand incandescent electric lamps will be employed in the illumination of the World's Fair grounds and buildings.

The largest glass bottle ever made in the world will be exhibited at the World's Fair, St. Louis, this year. It was blown in the plant of the Illinois Glass Co., at Alton, Ill.



MEANT WHAT SHE SAID.

Miss Utaplace—"Allow me to introduce you to my perspective husband."

Miss Parcavenue—"You mean your 'prospective husband,' don't you?"

Miss Utaplace—"I mean exactly what I say. He's a draftsman."—*Baltimore American.*

TROUBLE.

Trouble's comin' soon enough.
I'se a-gwine to wait.
Won't rush f'um de front room do'
To meet it at de gate.
If it's out to catch you,
'Tain' much use to run;
So you might as well be happy
While you has a chance foh fun.

Trouble's mighty curious.
Don't wear out a bit.
De mo' of it you has, de mo'
You's liable to git.
An' yet it's mighty timid;
You'll learn it after while.
Like dem microbes in de sunshine,
You kin kill it wif a smile.

—*Washington Star.*

TRAIN TIME.—Nextholidayatwhichthisyearstops is Decoration Day.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Device for Gas Engines.

A simple device for a gas engine is shown in Figs. 1 and 2, that will act as a governor, and stop the engine, should the water that keeps the cylinder cool be for any reason shut off.

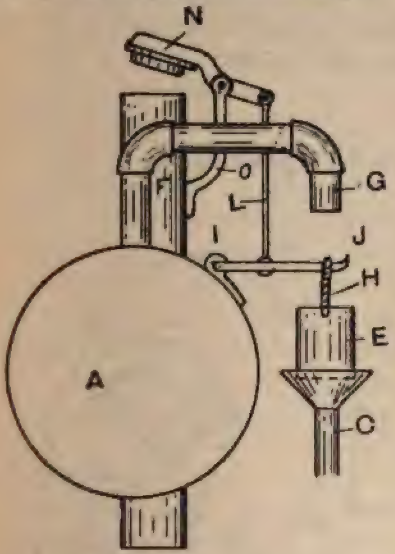


FIG. 1.

out if anything should happen to it.

The engine under consideration is of the type using a gas jet to ignite the charges. The boy, no matter how often he was told would forget to turn

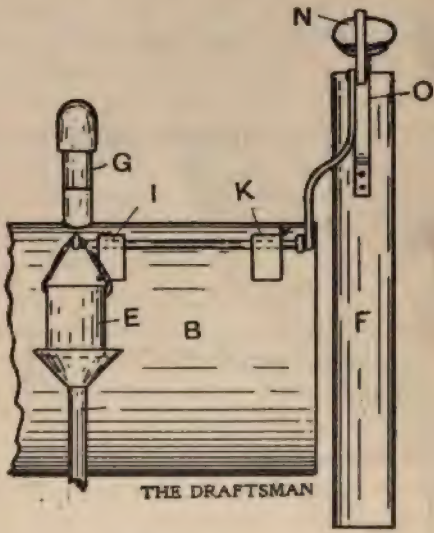


FIG. 2.

It was not gotten up for something new to manufacturer, nor is it for sale, but came about through the carelessness of the boy whose business it is to start the power going and keep a look on the water when he started the engine, and of course the cylinder would get hot in a few minutes and the engine would not go. It was then necessary to turn the water on and wait till

the engine had time to get cool, stopping all the machines for at least fifteen minutes. Something had to be done or the engine would be ruined.

Referring to the sketches, Fig. 1 is a sectional elevation looking from the crank end, and Fig. 2 is a part side elevation. The sketches are not uniform and are merely given to show the principal of the water cut-off.

A & B represent the cylinder, f the lamp chimney or igniting tube, g the pipe through which the warm water is discharged from the jacket of the cylinder, and C the funnel topped waste pipe carrying off the water.

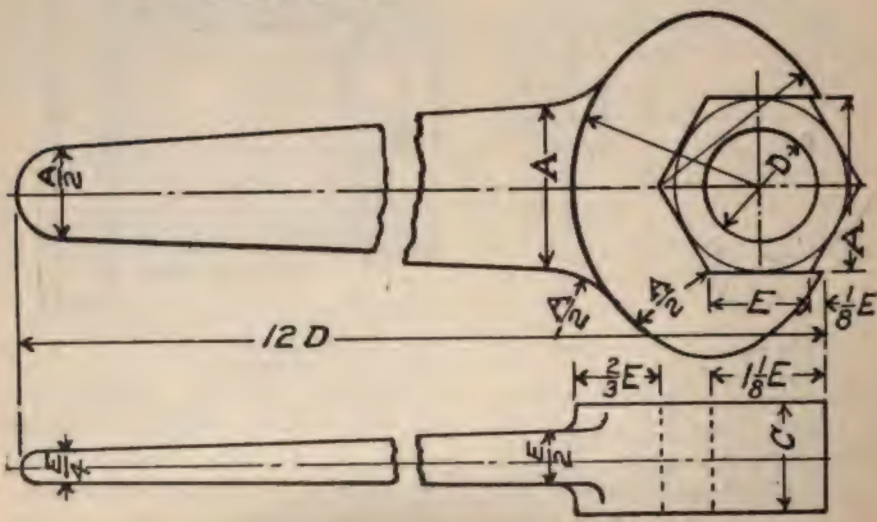
The rod J has a crank at each end and is carried in bearings i and k.

The tin cup e is hung by a small chain bale to the crank rod at J, directly under the drop of the stream of water from the pipe g to the waste pipe c. The tin cup e has a nail hole in the bottom. At the opposite end of the rod J, is a shorter crank to which the rod l is pivoted at its lower end. A bearing o is fastened to f, having at its upper end the pivoted cover n to the igniting tube f. The cover n is shown raised as it is when the engine is running. The igniting jet can not be lighted when this lid is down, and if raised and the gas lighted, it will go out the instant it closes the top of the tube. Before the engine can be started, the water must be turned on, fill up the jacket and overflow through g, fall into and fill up the tin cup, which form a weight to raise the cover n. The can gets full and runs over in the funnel, but if the water be turned off, the water in the cup leaks through the nail hole in bottom, reducing the weight until it will hold the cover n no longer, when it closes the top of f, and stops the engine.

Dimensions of Open End Wrench.

A = 1½ D.

D = Diam. of Bolt.



MECHANICAL.

The Economy of the Slide Rule.

CARL G. BARTH, M. E.

The Invention of Slide Rule for Accurately Fixing the Feed and Speed of Power-Driven Machine Tools is one of the Most Useful Economical Assets in Factory Management.

* * *

In a paper on "Shop Management," read at the Saratoga meeting of the society in June last, Mr. Fred W. Taylor referred to certain slide rules that had been invented and developed under his supervision and general guidance, by means of which it becomes a comparatively simple matter to determine that feed and speed at which a lathe or kindred machine tool must be run in order to do a certain piece of work in a minimum of time.

These slide rules were also mentioned by Mr. H. L. Gantt in his paper, "A Bonus System of Rewarding Labor" (New York meeting, December, 1901), as being at that time in successful use in the large machine shop of the Bethlehem Steel Company, and reproductions of a number of instruction cards were therein presented, the dictated feeds and speeds of which had been determined by means of these slide rules.

Mr. Taylor early set about making experiments with a view to obtaining information, in regard to resistances in cutting steel with edged tools, and also the relations that exist between the depth of cut and feed taken to the cutting speed and time that a tool will endure; and he advanced far enough along these lines in his early position as engineer for the Midvale Steel Company to make systematic and successful use of the information obtained; but as this, of course, was confined to tempered carbon tools only, it was not applicable to the modern high-speed steel, so that the invention and introduction of this steel called for new experiments to be made.

These were first undertaken under Mr. Taylor's directions at Bethlehem, so far as the cutting of steel alone was concerned; and later on at the works of William Sellers & Co., Inc., of Philadelphia, at which place the writer spent 15 months in going over these experiments again, on both steel and cast iron, and with tools of a variety of shapes and sizes, for which nearly 25 tons of material were required.

However, it is not the writer's intention at this time to give an account of these experiments, or of the results obtained and conclusions drawn from them, but merely to give some idea of the slide rules on which these have been incorporated, and by means of which a most complex mathematical problem may be solved in less than a minute.

He will also confine his attention to

the most generally interesting of these slide rules; that is, the slide rules for lathes, and he will take for an example an old style belt-driven lathe, with cone pulley and back gearing.

Considering the number of variables that enter into the problem of determining the most economical way in which to remove a required amount of stock from a piece of lathe work, they may be enumerated as follows:

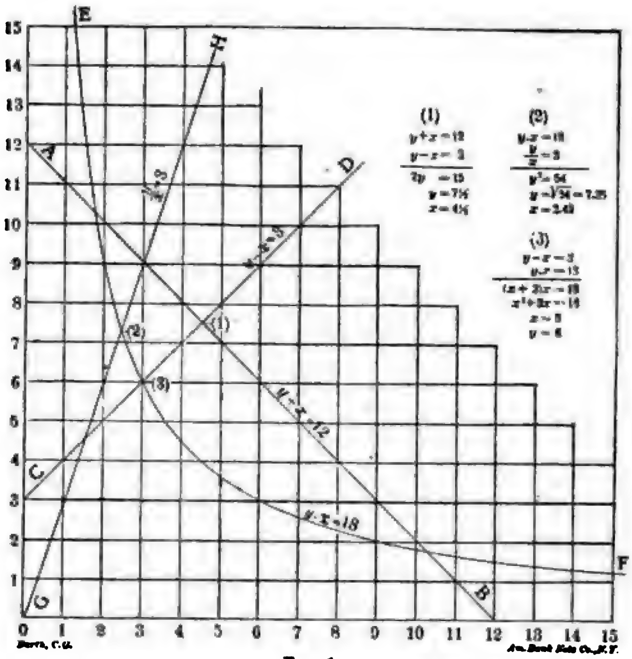


FIG. 1.

I. The size and shape of the tools to be used.

II. The use or not of a cooling agent on the tool.

III. The number of tools to be used at the same time.

IV. The length of time the tools are required to stand up to the work (Life of Tool).

V. The hardness of the material to be turned (Class Number).

VI. The diameter of this material or work.

VII. The depth of the cut to be taken.

VIII. The feed to be used.

IX. The cutting speed.

X. The cutting pressure on the tool.

XI. The speed combination to be used to give at the same time the proper cutting speed and the pressure required to take the cut.

XII. The stiffness of the work.

All of these variables, except the last one, are incorporated in the slide rule, which, when the work is stiff enough to permit of any cut being taken that is within both the pulling power of the lathe and the strength of the tool, may be manipulated by a person who has not the slightest practical judgment to bear on the matter; but which as yet, whenever the work is not stiff enough to permit of this,

does require to be handled by a person of a good deal of practical experience and judgment.

However, we expect some day to accumulate enough data in regard to the relations between the stiffness of the work and the cuts and speeds that will not produce detrimental chatter, to do without personal judgment in this matter also, and we will at present take no notice of the twelfth one of the above variables, but confine ourselves to a consideration of the first eleven only.

Of these eleven, all except the third and tenth enter into relations with each other that depend only on the cutting properties of the tools, while all except the second, fourth and ninth also enter into another set of relations that depends on the pulling power of the lathe, and the problem primarily solved by the slide rule is the determination of that speed-combination which will at the same time most nearly utilize all the pulling power of the lathe on the one hand, and the full cutting efficiency of the tools on the other hand, when in any particular case under consideration values have been assigned to all the other nine variables.

If our lathe were capable of making any number of revolutions per minute between certain limits, and the possible torque corresponding to this number of revolutions could be algebraically expressed in terms of such revolutions, then the problem might possibly be reduced to a solution, by ordinary algebraic methods, of two simultaneous equations containing two unknown quantities; but as yet no such driving mechanism has been invented, or is ever likely to be invented, so that, while the problem is always essentially the solution of two simultaneous equations or sets of relations between a number of variables, its solution becomes necessarily a tentative one; or, in other words, one of trial and error, and involving an endless amount of labor, if attempted by ordinary mathematical methods; while it is a perfectly direct and remarkably simple one when performed on the slide rule.

The slide rule method of solution may, however, also be employed for the solution of numerous similar problems that are capable of a direct and perfect algebraic solution; and it will, in fact, be best to exhibit the same in connection with the simplest imaginable problem of this kind.

In the first place, the solution of two simultaneous equations may be graphically effected by representing each of them by a curve whose coördinates represent possible values of the two unknown quantities or variables, for them the coördinates of the point of intersection of these curves will represent values of the unknown quantities that satisfy both equations at the same time.

Example 1. Thus, we have $y + x = 12$ and $y - x = 3$ these equations are respectively represented by the two straight lines AB and CD in Fig. 1; and as these intersect at a point (1) whose coördinates are $x = 4\frac{1}{2}$ and $y = 7\frac{1}{2}$, these values will satisfy both equations at the same time.

Example 2. Suppose again that we have $x.y = 18$ and $y = 3$ and these equations are respectively represented by the equilateral hyperbola EF and the straight line

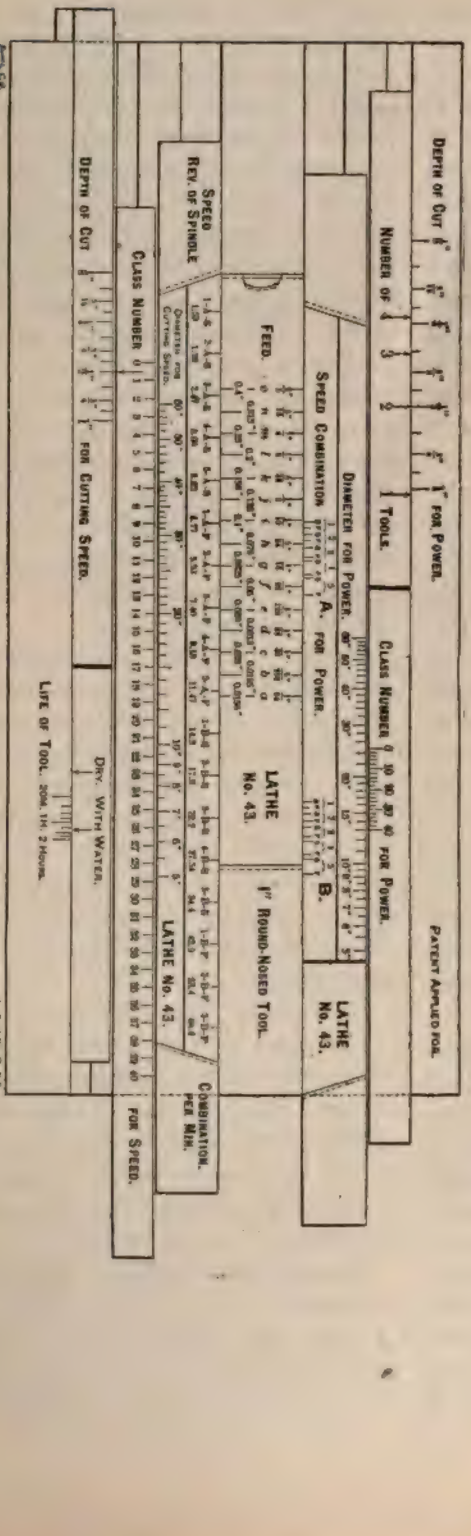

DEPTH OF CUT
FOR POWER.
NUMBER OF
TOOLS.
CLASS NUMBER
FOR POWER.
PATENT APPLIED FOR.
DIAMETER FOR POWER.
SPEED COMBINATION
A.
FOR POWER.
B.
LATHE No. 43.
FEED.
1" ROUND-NOSED TOOL.
SPEED
REV. OF SPINDLE
COMBINATION.
PER MIN.
CLASS NUMBER
LATHE No. 43.
FOR SPEED.
DEPTH OF CUT
FOR CUTTING SPEED.
DRY.
WITH WATER.
LIFE OF TOOL.

FIG 3

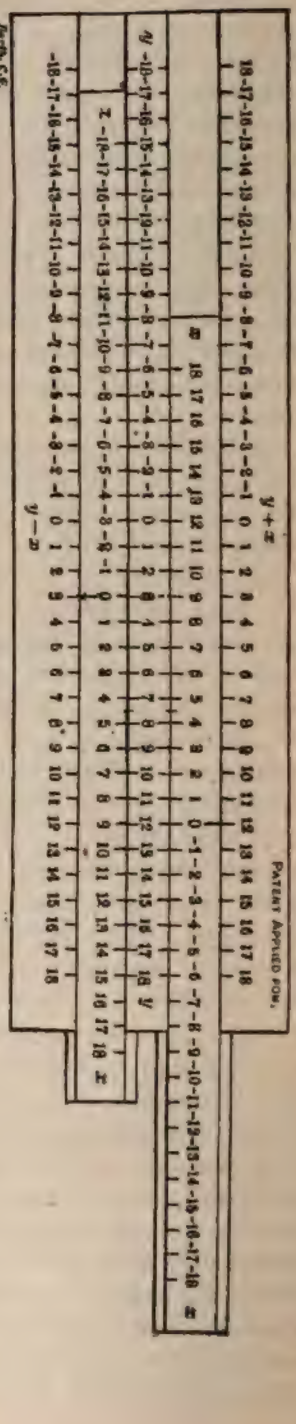

PATENT APPLIED FOR.
y + x
y
x
y − x

FIG. 2.

GH; and the coördinates to the point of intersection of these (2) being respectively $x = 2.45$ and $y = 7.35$, these values will satisfy both equations at the same time.

Example 3. Similarly, if we have $y - x = 3$ and $y.x = 18$ these equations are respectively represented by the straight lines CD and the equilateral hyperbola EF; and the coördinates to the point of intersection of these (3) being $x = 3$ and $y = 6$, these values will satisfy both equations at the same time.

The slide rule method of effecting these solutions—to the consideration of which we will not pass—will readily, be seen to be very similar in its essential nature to this graphical method though quite different in form.

In Fig. 2 is shown a slide rule by means of which may be solved any problem within the range of the rule of the general form: "The sum and difference of two numbers being given, what are the numbers?"

The rule is set for the solution of the case in which the sum of the numbers is 12 and their difference 3, so that we may write

$$y + x = 12 \text{ and } y - x = 3.$$

which are the same as the equations in Example 1 above.

In the rule the upper fixed scale represents possible values of the sum of the two numbers to be found, for which

FIG. 4.

the example under consideration gives $y + x = 12$ opposite which number is therefore placed the arrow on the upper slide.

The scale on this slide represents possible values of the lesser of the two numbers (designated by x) and the double scale on the middle fixed portion of the rule represents possible values of the greater of the two numbers (designated by y); and these various scales are so laid out relatively

to each other and to the arrow referred to, that any two coincident numbers on these latter scales have for their sum the number to which this arrow is set; in this case accordingly 12.

The bottom fixed scale on the rule represents possible values of the difference of the two numbers in this case 3, opposite which number is therefore placed the arrow on the bottom slide of values coincident to it in the two x scales on the slides; and this done, we readily discover in which direction we must move along the first scale in order to pick out that value of y which has the same value of x coincident with it in both x scales. For the case under consideration this value of y is $7\frac{1}{2}$, and the coincident value in both scales is $4\frac{1}{2}$. Evidently, therefore, $y = 7\frac{1}{2}$ and $x = 4\frac{1}{2}$ are the numbers sought.

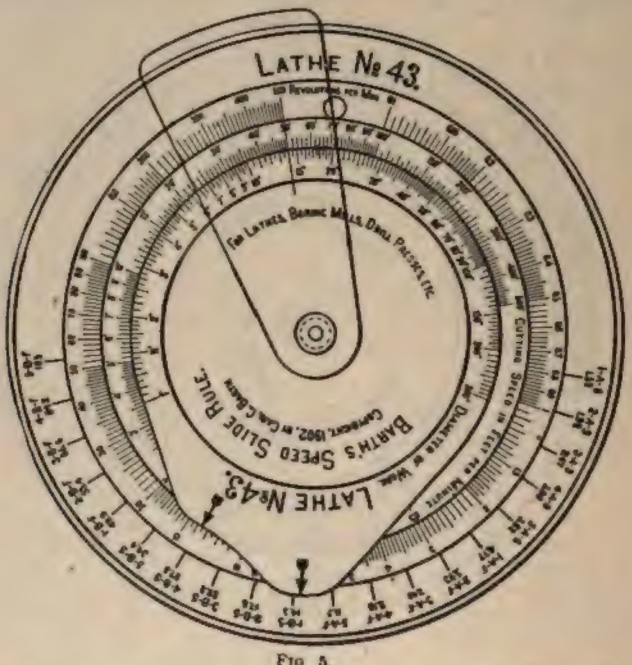


Fig 5.

the lesser of the two numbers, x; and the double fixed scale in the middle of the rule represented as already pointed out, possible values of y, the whole is so laid out that any two coincident numbers on these latter scales have for their difference the number to which this arrow is set; in this case accordingly 3.

Fixing now our attention on any number on the double y scale in the middle of the rule, we first note the

In the same manner we make a slide for Power became coincident with 14 rule for the solution of the general problem: "The product and quotient of two numbers being given, what are the numbers?"

Such a rule would differ from the above described rule merely in having longarithmic scales instead of plain arithmetic scales.

By the combined use of both arithmetical and logarithmic scales we may

even construct rules for a similar solution of the general problems: "The sum and product, or the sum and quotient, or the difference and product, or the difference and quotient, of two numbers being given, what are the numbers?" and a multiplicity of others; and the writer ventures to suggest that slide rules of this kind, and some even simpler ones, might be made excellent use of in teaching the first elements of algebra, as they would offer splendid opportunities for illustrating the rules for the operations with negative numbers, which are such a stumbling block to the average young student.

We now have sufficient idea of the mathematical principles involved, for a complete understanding of the working of the slide rule whose representation form the main purpose of this paper.

This slide rule, in a somewhat ideal form in so far as it is made out of neither steel nor cast iron, but for an ideal metal of properties between these two, is illustrated in Fig. 3. It will be seen to have two slides in its upper section and three in its lower section, and is in so far identical with the rules made for the Bethlehem Steel Company, while in the rules more recently made it had been found possible and convenient to construct it with only two slides in the lower section also.

It is shown arranged for a belt-driven lathe with five cone steps, which are designated respectively by the numbers 1, 2, 3, 4, 5, from the largest to the smallest on the machine. This lathe has a back gear only, and the back gear in use is designated by the letter A, the back gear out by the letter B. It also has two counter-shaft speeds, designated respectively by S and F, such that S stands for the slower, F for the faster of these speeds.

The Speed Combination 3 — A — S thus designates—to choose an example—the belt on the middle cone step, the back gear in, and the slow speed of the counter-shaft; and similarly, the combination 1 — B — F designates the belt on the largest cone step on the machine, the back gear out, and the fast speed of the counter-shaft; and so on.

The double, fixed scale in the middle of the rule (marked Feed) is equivalent to the y scale of the rule in Fig. 2, and the scales nearest to this on the slides on each side of it (marked Speed Combination for Power, and for Speed respectively) are equivalent to the x scales on the rule in Fig. 2. The rest of the scales represent the various other variables that enter into the problem of determining the proper feed and speed combination to be used, fixed values being either directly given or assigned to these other variables, in any particular case under consideration.

The upper section of the rule embodies all the variables that enter the question of available cutting pressure at the tool, while the lower section embodies all the variables that enter into the question of cutting speed; or, in other words, the upper section deals with the pulling power of the lathe, the lower section with the cutting properties of the tool; and our aim is primarily to utilize, in every case, both of these to the fullest extent possible.

The example for which the rule has been set in the illustration is:

A ½-inch depth of cut to be taken with each of two tools on a material of class 14 for hardness, and of 20 inches diameter, and the tools to last 1 hour and 45 minutes under a good stream of water.

The steps taken in setting the rule were:

1. The first scale in the upper or Power section of the rule, from above, was first set so that 2 in the scale marked Number of Tools became coincident with ½ inch in the fixed scale marked Depth of Cut for Power.

2. The second slide in this section of the rule was so set that 20 inches in the scale marked Diameter of Work in the scale marked Class Number for Power.

3. The first slide from below, in the lower or Speed section of the rule, was so set that the arrow marked With Water became coincident with 1 hour 45 minutes in the fixed scale marked Life of Tool.

4. The arrow on the lower side of the second slide in this section of the rule was set to coincide with ½ inch in the scale marked Depth of Cut for Cutting Speed.

5. The third and last slide in this section was so set that 20 inches in the scale marked Diameter of Work for Cutting Speed became coincident with 14 in the scale marked Class Number for Cutting Speed.

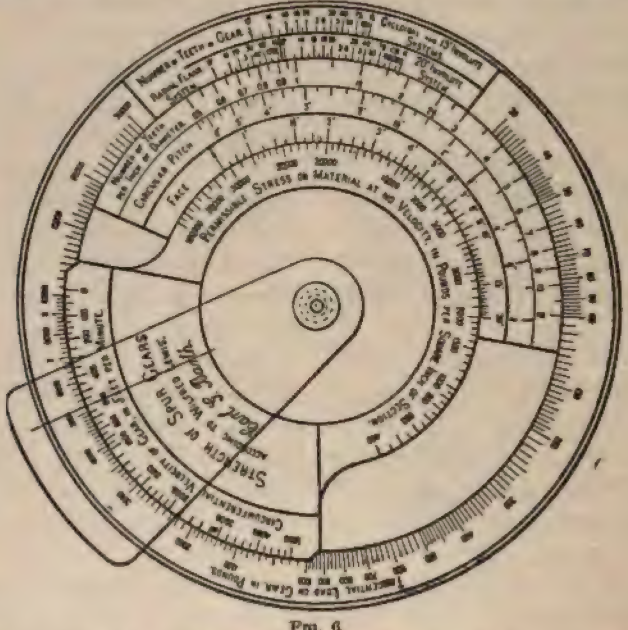


FIG. 6.

Let us now separately direct our attention to each of the two sections of the rule.

In the Power section we find all of the speed combinations marked B (back gear out) entirely beyond the scale of feeds, which means that the estimated effective pull of the cone belt reduced down to the diameter of the work does not represent enough available cutting pressure at each of the

tools to enable a depth of cut of ½ inch to be taken with even the finest feed of the lathe. Turning, however, to the speed combinations marked A (back gear in), we find that with the least powerful of them (5—A—F) the e feed, which amounts to 5-128 inch = 0.039 inch, may be taken; while the f feed, which amounts to 1-20 inch = 0.05 inch, is a little too much for it, though it is within the power of the next combination (5—A—S), and so on until we finally find that the most powerful combination (1—A—S) is nearly capable of pulling the i feed, which amounts to 1-10 inch = 0.1 inch.

In the Speed section of the rule we likewise find that all the B combinations lie beyond the scale of feeds, while we find that the combination 5—A—F (which corresponds to a spindle speed of 11.47 revolutions per minute), can be used in connection with the finest feed (a) only, if we are to live up to the requirements set for the life of the tool; while the next combination (4—A—F) will allow of the e feed being taken, the combination 3—A—F of the f feed, and so on until we finally find that the combination 3—A—S is but a little too fast for the coarsest (o) feed, and that both of the slowest combinations (1—A—S and 2—A—S) would permit of even coarser feeds being taken so far as only the lasting qualities of the tools are concerned.

We thus see that there is a vast difference between what the Power section of the rule gives as possible combinations of feeds and speeds for the utilization of the full pulling power of the lathe, and what the Speed section of the rule gives for such combinations for the utilization of the tools up to the full limit set. However, by again running down the scale of feeds we find that, in both sections of the rule, the i feed (0.1 inch = 0.1 inch) is but a trifle too coarse for the combination 1—A—F, while the b feed (5-64 inch = 0.078 inch) is somewhat too fine in connection with this speed combination 1—A—F, both for the full utilization of the pulling power of the belt on the one hand, and for the full utilization of the cutting efficiency of the tools on the other hand.

In this case, accordingly, the rule does not leave a shadow of doubt as to which speed combination should be used, while it leaves us to choose between two feeds, the finer of which does not allow us to work up to the full limit of either the belt or the tools, and the coarser of which will both overload the belt a trifle and ruin the tools a trifle sooner than we first intended to have them give out.

The final choice becomes a question of judgment on the part of the slide rule and instruction card man, and will depend upon how sure he is of having assigned the correct class number to the material or not; and this latter consideration opens up a number of questions in regard to the practical utilization of the rule, which for the lack of time cannot be taken up in the body of this paper, but which will be fully answered by the writer in any discussion on the subject that may arise.

Having decided upon the speed and now turns to the Time slide rule illus-feed to use, the instruction card man trated in Fig. 4, and by means of this determines the time it will take the

tools to traverse the work to the extent wanted, and making a fair allowance for the additional time consumed in setting the tools and calipering the work, he puts this down on the instrument card as the time the operator should take.

For finishing work the pulling power cuts no figure, so that this resolves itself into a question of feed and speed only; and for the selection of the speed combination that on any particular lathe will give the nearest to a desired cutting speed, the speed slide rule illustrated in Fig. 5 is used.

It will be readily realized that a great deal of preliminary work has to be done before a lathe or other machine tool can be successfully put on a slide rule of the kind described above. The feeds and speeds and pulling power must be studied and tabulated for handy reference, and the driving belts must not be allowed to fall below a certain tension, and must, in every way, be kept in first-class condition.

In some cases it also becomes necessary to limit the work to be done, not by the pull that the belts can be counted on to exert, but by the strength of the gears, and in order to quickly figure this matter over the writer also designed the Gear slide rule illustrated in Fig. 6, which is an incorporation of the formulæ established several years ago by Mr. Wilfred Lewis.

For the pulling power of a belt at different speeds, the writer has established new formulæ, which take account of the increasing sum of the tensions in the two slides of a belt with increasing effective pull, and which at the same time are based on the tensions recommended by Mr. Taylor in his paper entitled, "Notes on Belting," which was presented at the meeting of the society in December, 1893.

These formulæ have also been incorporated on a slide rule, but as the writer hopes at some future time to prepare a separate paper on this subject, he will not go into this matter any further at the present time.

Having thus given an outline of the use of the slide rule system of predetermining the feeds and speeds, etc., at which a machine tool ought to be run to do a piece of work in the shortest possible time, the writer, who has made this matter an almost exclusive study during the last four years, and who is at present engaged in introducing the Instruction Card and Functional Foremanship System into two well-known Philadelphia machine shops, which do a great variety of work in both steel and cast iron, will merely add, that in view of the results he has already obtained, in connection with the results obtained at Bethlehem, the usual way of running a machine shop appears little less than absurd.

Thus already during the first three weeks of the application of the slide rules to two lathes, the one a 27-inch, the other a 24-inch, in the larger of these shops, the output of these was increased to such an extent that they quite unexpectedly ran out of work on two different occasions, the consequence being that the superintendent, who had previously worried a good deal about how to get out the great amount of work on hand for these lathes out of the way, suddenly found himself confronted with a real dif-

ficulty in keeping them supplied with work. But while the truth of this statement may appear quite incredible to a great many persons, to the writer himself, familiar and impressed as he has become with the great intricacy involved in the problem of determining the most economical way of running a machine tool, the application of a rigid mathematical solution of this problem as against the leaving it to the so-called practical judgment and experience of the operator, can not other- perfect folly of the latter method.—Mill Owners.

Boiler Details

Boiler walls will crack, and no form of construction seems to entirely prevent this. Walls with air spaces are as liable as those without, with the danger of leaking more air when they do crack.

The best method to hold boiler walls together is with "buck-stays" or "buck-bars."

The best form is railway iron with ends mashed down under the hammer to allow for drilling holes for tie-rods. Most builders do not supply "brick-stays" unless specially ordered.

Generally, two brick-stays on each side and two on the ends will answer for boiler walls but three on each side would be much better.

SIZES OF BUCK-STAYS.

A	B	C	D	E	F	G	H
6—2	5	3½	1¼	⅝	½	2¼	11/16
8—9	5½	3¾	1½	¾	⅝	2½	11/16
10—2	6	4	1½	¾	¾	3	13/16

The illustration shows some sizes which the writer has seen used though it should be kept in mind that those placed on the end walls should have holes of a distance apart to match the casting containing the fire doors, in front.

The tie rods are usually ⅝ or ¾, and on large boilers ⅞ inches in diameter, and all sizes should be threaded on both ends, for square or hexagon nuts.

There is common sense in applying lugs made of boiler plate to steel boiler shells for their support. These lugs are made of flange steel 60,000 lbs. T. S. which is just about four times the strength of the same weight of cast iron. Rivet holes may be punched instead of the slow drilling process, if preferred.

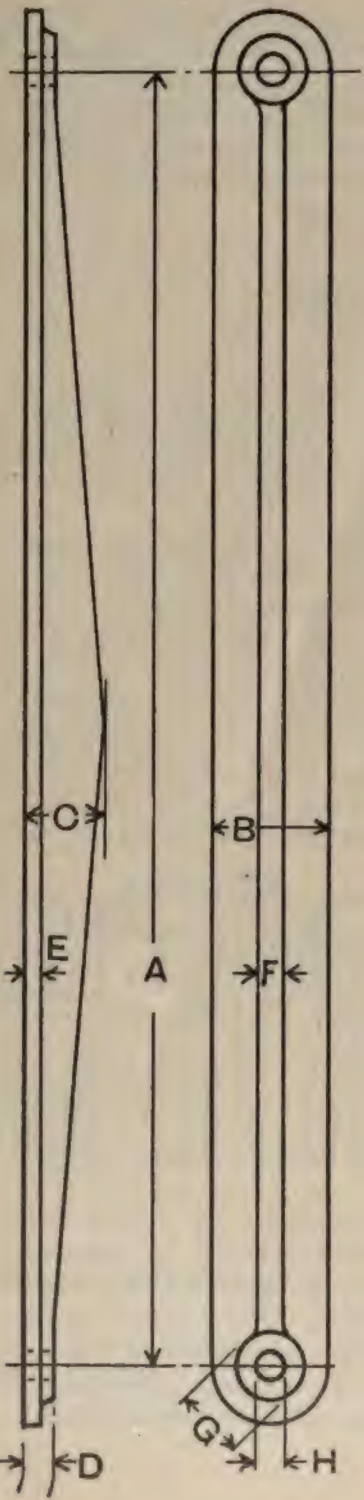
The fact that the lug and shell are

SIZES IN STOCK.

Diameter of Boiler Shell.	Height from Center of Boiler to Base of Lug.	Width of Lug, Inches.	Length, Inches.	Height, Inches.	Thickness, Inches.	Weight, Each (lbs.)	Equivalent to lbs. of Cast Iron.
36	5	6	9	7	1-4	10	40
42	5	6	9	7	1-4	10	40
44	6	7	11	8¼	9-32	15	60
48	6	7	11	8¼	9-32	15	60
54	7	9	13	10	5-16	24	100
60	7	9	13	10	5-16	24	100
66	8	10	15	11	3-8	36	130
72	8	10	15	11	3-8	36	130
78	9	10	15	11	3-8	36	130
84	9	10	15	11	3-8	38	150

of the same grade of material prevents all possibility of leaky rivets due to unequal expansion of cast lug and steel shell.

From the following table, the designer will have dimensions for the sizes and position on the boiler.



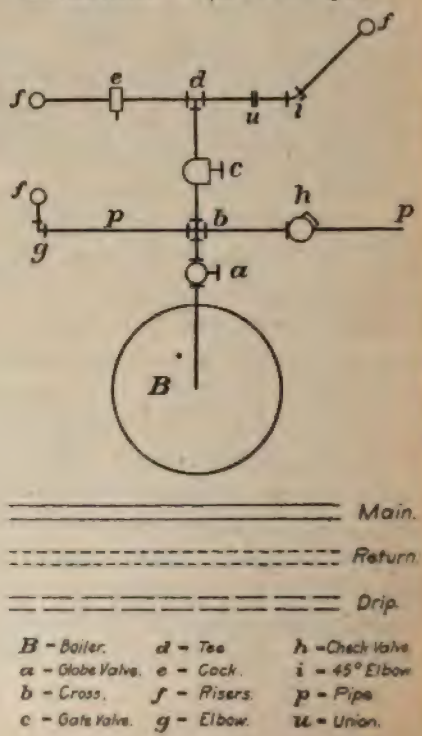
Two lugs on each side of the boiler will be sufficient, except in very long boilers where three would be better.

This style of lug known as the Drake-Castle Boiler Lug is carried in stock by Joseph T. Ryerson & Son, Chicago, Ill.

The conventional manner of showing pipe and fitting here produced is one shown on a supplement of

—*Machinery*.

Conventional Pipe Fittings.



Friction.

THE laws of friction are:

(1.) *It varies directly as the pressure between the surfaces in contact.*

2.) *It is independent of the extent of the surface in contact.*

(3.) *It is independent of the velocity, when the surfaces are in motion.*

These laws are, in actual practice, only approximately true; the first law not holding in the case where the pressures are very great, and the third law not holding beyond a velocity of about 150 feet per minute.

DIFFERENCE BETWEEN SLIDING AND ROLLING FRICTION.—"In rolling friction, the surface of at least one of the two bodies in question is bounded by a circular line, and the point of contact between the two bodies is thus reduced to a minimum. The particles in contact during the movement are also not *dragged along*, but *put down and lifted up*, by the rotary, or circular movement of the body, and the friction of sliding is avoided."

LAW OF ROLLING FRICTION.—In *rolling* friction, the friction is regulated not only by the pressure, but by the diameter of the rolling body. *The smaller the diameter of the body, the greater the friction.* Where the balls r cylinders are of the same substances, the law for rolling friction is: "*Rolling friction is directly as the pressure, and inversely as the diameter of the rolling bodies.*"

The above law, however, only applies to traction, where the load is moved by a direct pull or push on the axis of the rolling body—as in the case of a wagon or car; but, where the load is propelled by a crank fixed on the axle of the rolling body, *the law as defined is reversed;* for, in this case the smaller the diameter of the rolling body, the less the friction. For example: It is desired to move a freight train at the least expense of power. To accomplish this, the driving wheels on the locomotive are reduced, and the wheels on the cars increased; since the former propels, whilst the latter are propelled.

DATA.

Rolling friction:

Locomotive on dry rails at speed of about 10 miles per hour = 1-5th total weight. As the speed is increased, the adhesion is reduced.

Street cars on iron rails = 15 pounds per ton when rails are wet and clean, straight and new; 30 pounds per ton under average conditions.

Sliding Friction:	**Co-Efficient.** Ordinary Lubrication	Continues Lubrication
Cast iron in cast iron; Cast iron in gun metal	Average, .075 or $\frac{1}{13.3}$	
Wrought iron in cast iron; Wrought iron in gun metal		Average, .042 or 1-24th
Gun metal in gun metal; ordinary	.10 or 1-16th.	

ARCHITECTURAL.

Railway Freight Houses and Yards.

In a copy of *The Railway Age* is found the discussion of sizes of railway freight houses and necessary space around them for wagons and the following information was furnished by the representative of the different railroads present:

Philadelphia & Reading Railway.—The following information has been furnished by Mr. W. G. Besler, general superintendent:

1. Width of inbound and outbound freight houses 37 feet.

2. Width of platform along outside of freight houses 6 feet.

3. Width of platform for trucking between tracks 15 feet.

4. Width of driveways in yards where one or both sides are used for loading or unloading (clear width between sides of cars) about 26 feet.

5. Width of driveways at freight stations, where one or both sides are used for loading or unloading. At Thirteenth and Callowhill streets the width between inbound and outbound buildings is 60 feet.

6. Street grade in business district (average and maximum) 5 per cent.

7. Average and maximum loads of wagons; 2-horse teams, 2 net tons; some 3-horse teams haul 5 tons.

8. Total length of wagon, including horses, average, 26 feet 6 inches; maximum, 27 feet 6 inches.

9. Length of wagon with horses turned, average, 18 feet; maximum, 19 feet.

10. Width of wagon, over all: Average, 6 feet 2 inches; maximum, 6 feet 5 inches.

PITTSBURG.

Pittsburg & Lake Erie Railroad.—To Mr. J. A. Atwood, chief engineer, the committee is indebted for a set of sketch plans of all the freight stations in Pittsburg and Allegheny. As the actual layouts in various cities differ so widely (owing largely to local conditions), and as your committee's purpose is rather to lay down governing principles than to show actual existing plans, it has not been deemed advisable to reproduce these plans with the report. The following is a summary of the information given:

	Maximum.		Minimum.		Average.	
	Ft.	In.	Ft.	In.	Ft.	In.
Width of inbound and outbound freight houses	[illegible]	0	13	[illegible]	[illegible]	[illegible]
Width of platform along outside of freight houses	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]
Width of platform for trucking between tracks	12	0	[illegible]	[illegible]	10	[illegible]
Width of driveways between tracks where one or both sides are used for loading or unloading (clear width between sides of car)	[illegible]	0	18	0	21	[illegible]
Width of driveways of freight stations where one or both sides are used for loading and unloading (only one in Pittsburg)	37	6	......	....	....	...
Street grades in business districts	5.7%		......	...	2%	
Average and maximum load of wagons						
Length of wagon including horses	26	[illegible]	21	0	24	[illegible]
Length of wagon with horses turned	16	[illegible]	14	[illegible]	14	[illegible]
Width of wagon all over	......	....	....		6	[illegible]

Southern Pacific Railway.—Mr. J. L. Frazier, superintendent, has furnished answers to the questions asked as nearly as practicable. There are a

large number of freight sheds, which differ in width and length. The teams which handle freight vary in size from small wagons hauling 1,000 pounds or more, to immense 4-horse trucks hauling 10 tons. The surface of the city is much broken up; the business portion of it, however, is practically level.

1. Width of inbound and outbound freight houses 30 to 75 feet.

2. Width of platform along outside of freight houses 4½ to 5 feet.

3. Width of platform for trucking between tracks. None.

4. Width of driveways in yards, where one or both sides are used for loading or unloading (clear width between sides of cars) 40 to 45 feet.

5. Width of driveways at freight stations, where one or both sides are used for loading or unloading 48 to 51 feet.

6. Street grade in business districts. Average, .5 per cent.; maximum, 4½ per cent.

7. Average and maximum load of wagons 1 to 10 tons.

8. Total length of wagon, including horses, 20 to 40 feet.

9. Length of wagon with horses turned, 12 to 30 feet.

10. Width of wagons, over all 5½ to 9 feet.

-MEASUREMENT OF WAGONS AT CHICAGO.

No.	Total Length, Including Horses.	Length with Horses Turned, Feet.	Width, Feet.
1	[illegible]	17	7
2	22	12½	7
3	25	15	7½
4	31	22	8½
5	27	16	7½
6	27½	17½	7½
7	27½	17½	7
8	27	15½	7½
9	[illegible]	15	7½
10	[illegible]	14	7
11	[illegible]	15½	7½
12	[illegible]	17	7½
13	[illegible]	15½	7½
14	24	14½	7
15	[illegible]	15½	7½
16	[illegible]	15½	7½
17	25	15½	7½
18	[illegible]	19	8

Computing Strains in a Crane Derrick.

WILL you kindly publish in your paper or have Mr. Kidder give a method of computing the strains on the different parts of a crane derrick, as shown in the accompanying sketch, Fig. 1, and say if it would be practicable to build one of the dimensions indicated? The blocks on the boom would be on a carriage and run on the boom. The mast would be set on blocking 25 feet high. There would be four main guys from the top of the mast.

Answer.—We submitted the inquiry of our correspondent to Mr. Kidder, who furnishes the following: In reply to the question above I would say that it is practicable to construct a crane derrick as shown by the correspondent's sketch, provided the framework on which the mast sets is made sufficiently stiff to resist the horizontal thrust at the bottom of the mast, which is quite considerable. It will also be necessary to strengthen the mast by means of the "hog chain," as in Fig. 2. Otherwise the mast would break in two. The strains or stresses in the different parts of the derrick will vary with the position of the carriage on the boom, and will of course be greatest when the load is applied at the outer end of the boom. The derrick must be made strong enough to sustain the load in this position.

The stresses in the different parts

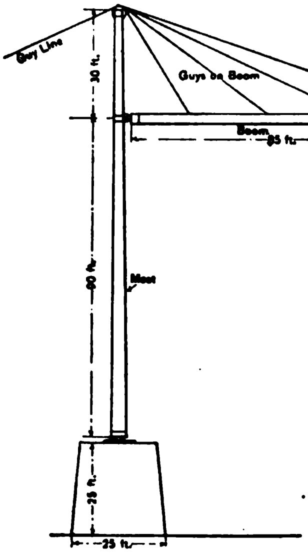


Fig. 1.—Diagram of Derrick Submitted by " H. O. R."

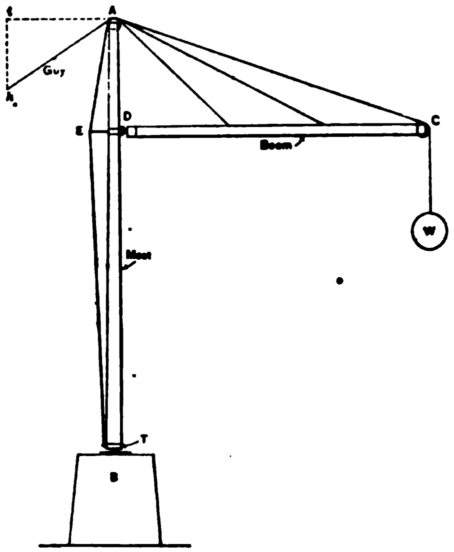


Fig. 2.—Diagram Contributed by Mr. Kidder.

Computing Strains in a Crane Derrick.

may be found as follows:

$$\text{Stress in boom} = \frac{\text{length C D.}}{\text{A D}} \times W$$

$$\text{Stress in A C} = \frac{\text{A C}}{\text{A D}} \times W$$

Stress in E D is the same as in the boom.

$$\text{Thrust, T, at the bottom of mast} = \frac{\text{CD}}{\text{A B}} \times W$$

$$\text{Stress in B E} = \frac{\text{BE}}{\text{ED}} \times T$$

$$\text{Stress in AE} = \frac{\text{AE}}{\text{ED}} \times (\text{stress in boom} - T)$$

$$\text{Compression in mast} = W + \frac{\text{BD}}{\text{D E}} \times T$$

All measurements should be in feet.

APPLICATION.—With the derrick in question, C D = 85; AD = 30: AC = 90.15; DB = 60. E D we will make 5 feet, which will give 60.2 for the length of B E and 30.4 for A E. We will assume W at 1000 pounds.

$$\text{The stress in boom} = \frac{85}{30} \times 1000 = 2833$$

pounds = stress in E D.

$$\text{Stress in A C} = \frac{90.15}{30} \times 1000 = 3005 \text{ bounds.}$$

$$\text{Thrust at B} = T = \frac{85}{90} \times 1000 = 944 \text{ pounds.}$$

$$\text{Stress in B E} = \frac{60.2}{5} = 944 = 11{,}365 \text{ pounds.}$$

$$\text{Stress in A E} = \frac{30.4}{5} \times (2833 - 944 = 11{,}485 \text{ lbs.}$$

$$\text{Compression in mast} = 1000 + \frac{60}{5} \times 944 =$$

12,428 pounds.

The boom and mast and strut *E D* are in compression; the other parts in tension. If *W* is 2000 pounds all of the stresses will be just twice as large —*i. e.*, the stresses will be in proportion to the load.

If the guy were horizontal the stress in it would be equal to *T*, provided the guy was in the same plane as the boom.

For an inclined guy the stress will be increased in the proportion that *A h* is greater than *A i*, or stress in

$$\text{guy} = \frac{\text{A h}}{\text{A i}} + T, \text{ h i being vertical.}$$

As the boom carries a traveling carriage it must be strong enough to resist both the compressive stress and the transverse stress, as a beam, when the carriage is half way between any two points of support.—*"Carpentry and Builder."*

Making a Five-Pointed Star with the Steel Square.

A writer in *Carpentry and Builder,* says: "I send herewith a couple of sketches for a five-pointed star which may meet the wants of "C. V. F.," Knightstown, Ind. Referring to Fig. 1, draw the two diameters A C and B D at right angles to each other. Bisect one of the radii, as *o* B, at I. Now with I as center and I A as radius describe an arc, A J, cutting D *o* at J. With A as center and A J as radius describe an arc, cutting the circumference at H. Draw the chord A H, and it will form one side of the pentagon. Finish the pentagon by spacing around the circumference, and then draw the lines A F, H E, E G and G A, completing the star. As the applicant, however, demands a way to perform this feat with the steel square, we will consider the operation in connection with Fig. 2. Here draw the diameter A C and then the line A B, and by reversing the square draw A D. Next draw B G and D H, after which B F and D E can be drawn, completing the figure by connecting F with E. I might say that the angles are all obtained by using the 7.21 on the square."

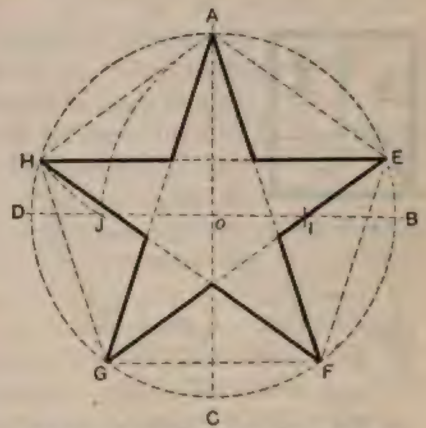
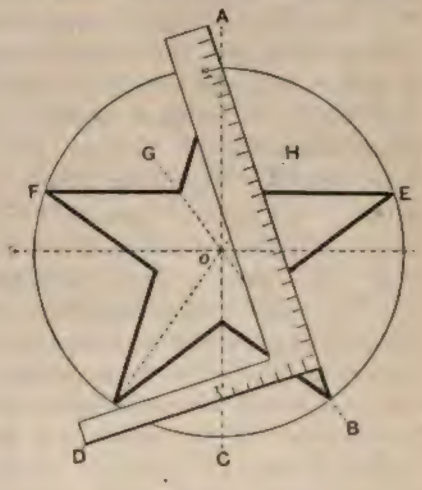


Fig. 1.—One Method of Making the Star.



STRUCTURAL.

Structural Design.

BY E. FIANDER ETCHELLS.

I AM asked to write a short article on the design of steel structures, and the trend of modern structural design. A short article must necessarily be sketchy and fragmentary, for to deal with the subject at all completely, a monopoly of the pages of this magazine would be required for the next twelve months. I might as well be asked to compress the whole art of structural design into a sixpenny telegram as to compress it into one short article. I can, however, give the pith in less than twelve words: (1) Learn from the artisan. (2) Use your common sense. (3) Study mathematics. Now let me be more definite. I say, learn from the artisan, because this appears to me to be the natural way, and it will prevent the student from designing structures and details which are impossible of execution or unnecessarily expensive. As an instance of this, I have seen steel stanchions with gusset-plate cut to the curve of a true ellipse, instead of leaving a straight edge. These unnecessarily expensive gussets were not for a theatre or restaurant, but were under some coal-bunkers. I say, use your common sense, as this will prevent students crowding two ¾-in. rivets into a 2½-in. bar, or showing rolled steel joists on the drawing which cannot be found in any maker's list. I have seen both these things done, not by students, but by alleged professional men. In fact, I was once informed that a rolled steel cantilever, unknown to any maker's list, but proposed to be used for a projecting street sign, "would be specially rolled." I say, study mathematics, because it will ultimately save you, or your employers, hundreds of pounds in economizing material by the right proportioning of parts, and will enable you to cut your materials to finer limits than if you had only vague notions of the possible forces on each bar or member. In the old days, men ensured safety by putting in extra material, and being very lavish when in doubt. Now that competition is so keen, and contracts are frequently let on the lowest tender, economy of design is very essential. Thousands of pounds are wasted annually through badly-proportioned structures. At this moment I have in view a football stand, to shelter a definite number of people, which was ordered on the express condition that it was not to cost above a stated amount. The makers complained afterwards that they had lost on the work. Now an analytical investigation of the strengths of the various parts showed than an equally strong structure could have been pro-

[illegible]

I append a table showing the comparison of the maximum safe loads from various section books for a rolled steel joist.

Comparison of Tabulated Safe Loads from Various List.

The section chosen for comparison is 10" x 6" rolled steel joist, span 10 feet. All figures are for distributed stationary loads.

Section Book.	Weight of Joist per foot.	Maximum safe load in tons.	Maximum stress on extreme fibres.	Nature of end conditions.	Ultimate statical tensile strength of steel.
	lbs.		Tons p. sq. in		Tons per sq. in.
A	39	18·	7·5	?	28 to 32
B	45	18·4	6·4	free	28 to 32
C	42	19·7	7·0	"	28 to 32
D	42	21	7·5	"	28 to 32
E	45	23	8	"	28 to 32
F	42	25	10	"	28 to 32
G	42	25	?	?	?
H	42	26	?	fixed	?
I	42	26·2	?	"	?
J	42	28·6	?	free	28 to 32
K	45	30	?	"	28 to 32
L	45	30·7	10	"	28 to 32

It will be noticed that, according to the list, the maximum safe uniformly distributed load on a 10-in. × 6-in. rolled steel joist for a span of 10 ft. varies between eighteen and thirty-one tons, *i. e.*, a difference of 70 per cent. between the lowest and the highest. The variety in these results does not arise solely through the quality of steel used, but chiefly from the factor of safety employed, and the different assumptions as to the fixity or freedom of the ends. Unfortunately, some of the lists do not give these essential details, or they are given in small print and demand laborious searching after, yet thousands put their whole trust in these lists with a faith that is amazing in this sceptical age. At this juncture I would impress upon all students, architects and draftsmen the necessity of giving the weight of a joist as well as its depth and width. For instance, 10 in. × 6 in. rolled steel joist leaves us in doubt whether a 39-lb. or 45-lb. joist is intended, and we are consequently ignorant of the strength of the joist intended. The same thing applies to steel angles and tees. It is not sufficient to say a 3-in. × 3-in. It is necessary to give the thickness as well. Is ¼ in. thick intended, or ¾ in.? This may seem a trifling matter, but I assure my readers that on architect's drawings this third dimension is frequently most noticeable by its absence. Such omission is as bad as ordering a pot of paint and not specifying the color.

If you are to be successful as structural engineers it will be necessary to keep notes of all the standard details you can, and to gather trustworthy formulæ for the most frequently occurring problems. As an instance of standard practice, I give a copy of some fragmentary notes I have found useful in settling the details of bases of rolled steel stanchions for small sheds.

STOCK SIZES OF ROLLED STEEL STANCHION BASE FOR SMALL SHEDS.

Outside dimension	Base Plate	Size of angles	Rivets
Inches	Inches	Inches	Inch
6x3	12x8x⅝	3 x 3 x [illegible]	¾ diameter
6x5	12x10x[illegible]	3 x 3 x [illegible]	¾ "
7x3¾	12x10x[illegible]	3 x 3 x [illegible]	¾ "
8x4	12x10x[illegible]	3 x 3 x [illegible]	¾ "
8x5	15x12x[illegible]	3½x 3½x [illegible]	¾ "
10x4½	15x12x½	4 x 4 x ½	⅞ "
10x5	15x12x½	4 x 4 x ½	⅞ "

As an instance of frequently occuring formula, I give the useful formula for normal wind pressure against inclined surfaces, together with a note or two on its simplification.

$P_n = P \sin a^{1 \cdot 84 \cos a - 1}$ (Unwin)

where P = pressure of wind per unit area on a surface at right angles to the direction of the wind.

a = angle of inclination of the direction of wind to a second surface.

P_n = normal pressure of wind per unit area on this second surface.

Unwin states "that the usual direction of the wind is probably horizontal, though it is quite possible that this direction may occasionally make a considerable angle with the horizontal, becoming, for example, normal to a roof of high pitch."

In practice, the pitch of roofs usually lies between 10 degrees for lean-to roofs and 60 degrees for Gothic roofs. Between these limits the normal wind pressure can be found from the following simpler formula, which gives practically the same result as Unwin's.

$$P_n = P \sin B \times \sin B$$
$$= P \sin^2 B$$
$$\text{where } B = 1 \cdot 2\,a + 18^\circ$$

For roofs higher than 60 degrees, the maximum horizontal wind pressure should be taken in preference to either formula.

In this matter of wind pressure, there are two other notes of outstanding importance. First, in an open lean-to shed with a flat roof, the wind may strike the face of the main building and beat downwards with great force, and destroy the flat roof; or, on the other hand, a wind pocket may be formed by the lean-to shed, and the wind, finding no escape, will lift the roof, so that our calculations of the horizontal component of the wind pressure on inclined surfaces becomes useless, as they do not apply to the case in hand. In dealing with flat roofs of this description, it becomes necessary to securely bolt them down, and to design them to safely stand a vertical downward pressure of at least 40 lbs. per square foot of ground plan, or an upward pressure from the under side of 20 to 30 lbs. per square foot, according to circumstances. In the case of downward pressures, this 40 lbs. includes the weight of the roof; and in the case of the 20 to 30 lbs. upward pressure the weight of the roof must be deducted to get the net upward pressure. These heavy pressures for flat roofs are justified by the experiments of Mr. Irminger, given in *The Gas World*, 6th May, 1899, and in greater detail by Mr. Nielsen in *Engineering*, on the 9th October, 1903. Mr. Irminger, however, takes up the subject from an entirely different standpoint. Secondly, it is also essential to remember that Hutton's experiments, on which the two formulæ given in this paper are based, were made on inclined surfaces with free escape of air on every side. Professor Kernot, of Melbourne University, has constructed a blowing machine, giving a fairly steady jet of air about 1 square foot in cross sectional area. To this jet he exposed numerous models of buildings, and measured the wind pressure on the various surfaces. He found the only cases in which the ordinary methods of calculations for wind pressure on roofs agree with practice are: 1st. A roof on columns with free air space underneath. 2nd. A roof lying on the ground without raised supports.

In the case of a roof supported on walls as far as the eaves, no pressure whatever was experienced on the roof.

In the case of a roof on walls, having parapets above the eaves, there was actually a negative pressure, producing a decided tendency to lift (*vide* Lineham's "Mechanical Engineering" and the "Transactions of the Australasian Association for the Advancement of Science," Vols. V. and VI.).

I give these notes here, as they are rather too recent to have found their way into the generality of text-books.

In dealing with corrugated roofs, it must also be borne in mind that there is greater necessity for longitudinal wind bracing, as the wind will catch the sides of the corries, and produce a racking tendency. If this is not taken up by wind bracing, it will be taken up by the sheets themselves, with the result that the hook bolts may work loose in the holes in the sheets. In designing open sheds for wharves, etc., it is often desirable to use angles and tees even for the tension members, so that the roof will not fail even if the wind does get under it. If the shed is open on all sides, this is not so necessary as when it is closed on three sides with the fourth side open to the river or dock.

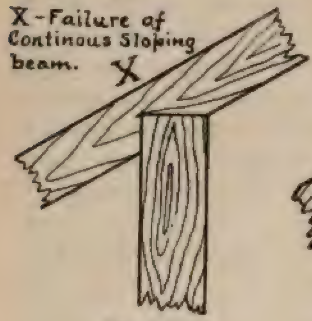


Fig. 1.

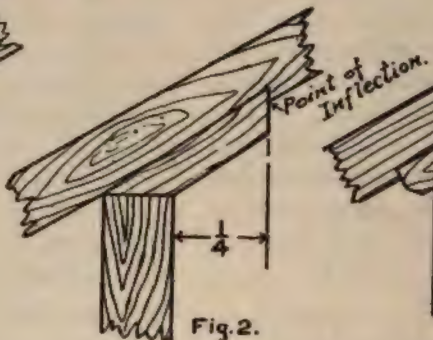


Fig. 2.

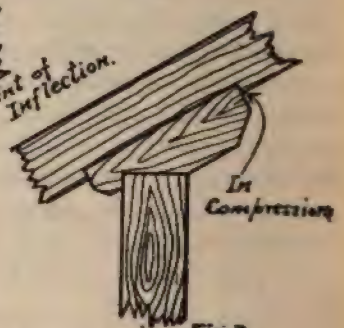


Fig. 3.

Let us, however, turn from particular designs to designs in general. There is one general aspect of structural engineering which would considerably assist our progress in all its branches.

It is to realize, and to realize fully, that no matter what structure we take up, it is to be considered as a particular instance of the doctrine of evolution. Any given structure is as much the product of evolution as any particular animal is the product of evolution in the organic world. There is a continuous chain of progression between the first stepping stones thrown across a rivulet and the great spans of the Forth Bridge. There is an unbroken connection between the lake dwellings of pre-historic Europe and the ferro-concrete residence of M. Hennebique, of Paris. Some of the recent stages in this evolution are very clearly seen. Take first the wooden roof with the parts tied together by thongs or cord, as seen to-day in the South Sea Islands. At a considerably later stage of development, we see wooden roofs with iron nails or bolts through the joints. Next we meet with composite roofs, with wooden struts and rafters, and iron tie-rods.

After this we find all-iron roofs. Later the iron is replaced by steel roofs and corrugated iron sheeting.

Take next the case of floors with wooden floor joists and wooden flooring. This differentiation of function betokens considerable previous development. These wooden floor joists are later replaced by steel joists with concrete filled in between. At a later stage we meet with steel floor joists completely imbedded in concrete. This leads to the use of floors of concrete with diminutive joists running through. The most recent stage of this tendency is seen in the distribution of steel into numerous round bars of small diameter running through the tension side of the concrete, as exemplified in the case of the Hennebique constructions.

Fig. 4.

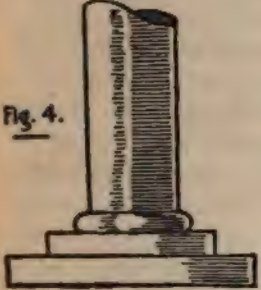


Fig. 5.

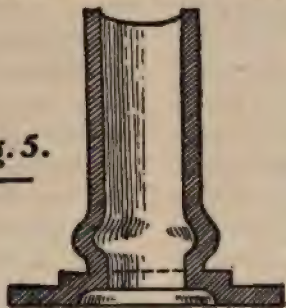
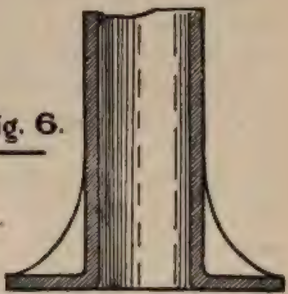


Fig. 6.



The advantage of this comprehentive view of the subject is, that the student feels greater confidence in himself when he realizes that any particular type of structure is only one link in a great chain, instead of each type of structure being "a special creation" with a special set of rules, formulæ, and diagrams. In this great, slow march of evolution, experience and theory each take their due part. Neither theory nor practice is predominant, but they are each complementary. Improvements in design are forced upon our attention largely by accidents and disasters which have occurred in the past, and theorising as to how they may be prevented in the future. That is, our structural successes are amendments on the structural failures of the past, and we to-day are making mistakes which those who come after us will have to rectify. During November, 1903, some railway arches collapsed between Cheltenham and Honeybourne, on the Great Western Railway, during process of construction. An enquiry will be held as to the cause. These arches will be compared with other arches which have stood the test of time, the materials will be examined, suggestions as to the cause of failure will be put forward, and various theories will be tried and tested; till, by a process of elimination, we find the true cause or causes of failure. The knowledge gained will thus be of use to us in designing and erecting the new arches or foundations. It is by such a process as this, though not necessarily so speedy, that each modern building or structure has evolved, and if we would desire a comprehensive view of the wide domain of structural engineering, we must look at every structure from the standpoint of evolution. I would, however, clearly im-

press upon you that I do not for a moment assert that every structure is an advance on its structural predecessor. Evolution includes such phases as arrested development, atavism, atrophy, and successive cycles of evolution. I have seen modern structures which would throw discredit on a builder of a mud cabin. I have seen the central pier of three piers made weaker than the end ones, although it took the greatest load. The failure of a football stand recently was due largely to "bird-mouthing" the raking beams at one of the points of maximum bending movement. (See Fig. 1). Alternative methods allow us to get the bearing surface without materially affecting the transverse strength of the beam, as shown in Figs. 2 and 3.

There is another important point in structural evolution to which attention should be drawn. It is the persistence of certain forms and details long after the use or necessity of that form has passed away. This persistence of early forms is most clearly seen in much of our modern ornaments, as these forms frequently served some real and useful purpose in the past. Let us take the case of a column. (See Figs. 4 and 5.) Here the contour is rational when executed in wood, or blocks of stone, but when this form is used for cast iron column it becomes meaningless, and even a source of weakness. A more suitable form for a cast iron column base is given in Fig. 6. Among other "vestiges of earlier forms" must be classed the meaningless spandrels or ornamental brackets under the rolled steel cantilevers of the iron and glass shelters outside hotels and theatres. In the days of wooden hoods or cast iron cantilevers, they served a useful purpose, but under a rolled steel joist they are almost invariably superfluous and very frequently a public nuisance.

It is also an essential principle of good design that every structure should be the "fittest" for the work it has to do. Herein lies the beauty of the bridge over the River Nervion, shown at the beginning of this article. Here will be found the horizontal beams forming the roadway, the vertical pillars in the spandrels, carrying the load from the flooring down to the arch itself; and the arch poised between pier and bank in such a curve that we seem almost to visualise the line of resistance sweeping through the arch's centre-line. We see also the sloping abutments, and the piers spread out to distribute the loads over the requisite foundation area. There is in every point such adaptability of form to function as must needs command approval. I believe it was John Strain, Member of the Council of the Institution of Civil Engineers, who first introduced concrete arches, but we have in this ferro-concrete arch across the Nervion what is doubtless the latest production of the structural engineering world. It is for the students of to-day to declare, in their maturity, whether this type of construction will hold its own in the commercial struggle for existence.—*"Technics."*

Think all you speak, but speak not all you think.

Let ambition be the foundation on which built the monument of success.

PATENT DRAFTING.

Patent Office Practice.

BY C. W. H. BROWNE,

of the National Correspondence Institute.

THE reproduction of drawings by means of the photolithographic process is simple, but at the same time it is particular work, for if not properly started it would give poor results no matter how well the last part of the work is done.

The first thing that is required for this purpose is that the drawing should be made clean and clear, all surface shading, either of convex, concave, or flat surfaces should be open, but the lines need not necessarily be far apart; each line should be clean cut, no ragged edges, and the lines should be distinct from each other.

If you have a first-class drawing the process is as follows:

First, a negative is taken by the wet plate process (this process is considered the best for this purpose). The reproduction should be a little smaller than the original, as it gives better results, for in reducing, many of the small defects in the drawing, such as a little roughness of lines, will be benefited.

Second, after the negative is properly developed and dried, a print is taken on a particularly sensitized paper, the background is a bright yellow, while the printed lines are a light brown. The peculiarity of this paper is that lithographic ink will not adhere to the yellow background, but will to the brown lines.

Third, a lithographic stone is placed on a transfer press and is inked all over, as evenly as possible with lithographic ink. The print is then placed face down upon the inked stone, with the top of the drawing facing the back of the press. The stone is then run through the press under pressure; the pressure is removed and the stone returned to its first position; the print is carefully lifted off and should be perfectly black all over. Now, if there were any uneven places in the face of the stone, some parts of the print would not have as much ink as others, so, as a safeguard, the print is again placed on the stone face down, but the top of the drawing is placed in the opposite direction. It is again run through the press. Running the print through the press twice in this way will reduce to a minimum any unevenness of inking.

Fourth, the print being covered entirely over with lithographic ink, it is laid flat on a smooth, hard surface (glass is generally used), face up. A wet sponge is used to wash off all the

ink, and, as has been previously stated, the ink will not adhere to the yellow background, but only the brown lines showing the drawing. We now have a print that is a reproduction of the drawing with the lines shown in ink. This print is dried and afterwards is given to the transferrer to transfer to the stone. The transferrer places the dry print face down on a lithographic stone, places a layer of paper over the print and drops an iron frame which holds a piece of zinc on the stone. The stone and iron frame with the zinc is then run through the press under great pressure, which is a squeezing pressure. The pressure is taken off and the stone brought back to its original position, the iron frame lifted up, and the layer of paper removed. It is then found that the print has adhered to the stone. The back of the print is thoroughly wetted so that the print can easily be removed. Sometimes only a part of the print will come off; if so, it has to be wetted again. Great care must be used in taking the print off. After it has all been removed it will be found that the ink that was on the print has been left on the stone. These slight ridges of ink on the stone are the base for adding more ink. The stone is again wetted with the sponge, and an ink roller is passed over it. As the ink is greasy and the stone is wet, the ink will only adhere to the ink lines that were previously pressed on the stone. The transferrer now looks at the transfer on the stone, and cleans off with a sharp steel tool any spot or foreign substance that does not belong there. When this is done he washes the stone over with a weak solution of nitric acid, which cuts the stone down between the ink lines. Of course it is only a very small fractional part of an inch, but it is enough for the purpose if the lines of ink are slightly raised. The stone is now ready to go to the steam lithographic press where the desired number of copies are printed, but in printing, the stone is always kept wet, so that as it passes under the ink will only adhere to the ink lines.—"*Spare Time Study.*"

Telephone wires are often rented for simultaneous telegraph use, by companies operating long distance systems, for as much as $20 a mile, annually, for twelve hours' service daily. The telegraphing goes on at the same time with the regular telephone use of the wires. The United States Telephone Company, which has a system centered in Cleveland, rents thousands of miles of wires for simultaneous telegraph use. Its customers are mainly brokers and other business houses.

Near Crefeld, Germany, many looms are run in the homes of weavers by electric motors of one-fourth to one-half horse-power, the current being supplied from a central station, where the power is generated on a large scale, at the minimum cost and with the most approved machinery. In many parts of Europe, it is believed, there will be a great extension and revival of home industries by the aid of power obtained in this manner from great distributing stations, where it can be produced at small cost and controlled by experts.

HOME STUDY.

Elementary Course in Mechanical Drawing

(Continued from May Issue.)

Working Drawings, and Tracings.

CHAPTER VI.

The first thing to be considered when about to make a working drawing of an object is how much must it be reduced to go on the sheet.

If small enough to be represented full size in two or three views, so much the better but when too large for that, a suitable *scale* must be selected that will give a drawing as large as possible to which the *full size* dimensions should be attached.

Fig. 1

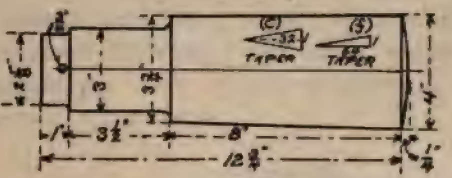


Fig. 2.

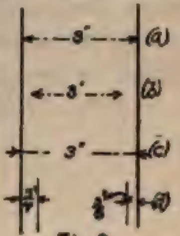


Fig. 3.

A good working drawing must not only be drawn to a scale but it should be fully dimensioned, for if it is not dimensioned, the workman must get his sizes from the drawing by applying his rule or a suitable scale, an operation which takes time and is very liable to result in error.

Some draftsmen place the figures for the dimensions so that they are all read one way, as in Fig. 1. Others again prefer the figures at right angles to the dimension lines as shown in Fig. 2. In marking the distance between two lines, be careful to put the arrow-points up to the lines as shown at (a) Fig. 3 and not as shown at (b). The arrow-points should also be put on the inside as shown at (a) and not outside as shown at (c) unless the lines are very close together, as shown at (d).

All dimensions which a workman may require should be put on the drawing so that no measurement of the drawing or any calculation need be made. It is not enough to give the lengths 1 in., 3½ in., 8 in. and ¼ in. of the different parts of the object in Fig. 2, but the length over all 12¾ in., which is the sum of all these lengths should also be marked. Fractions should be made with a horizontal line between the figures, never with an oblique line.

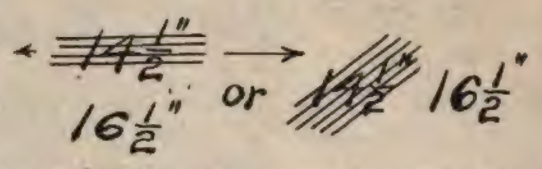
Where a hole is to be shown, the diameter is marked as in Fig. 2. It is assumed that it is a round hole and

that it will take a drill of that size. If the hole is to be threaded, mark it the size of tap required, that is, if we write "⅜ in. tap," it will need a drill smaller than ⅜ in. and when finished with the tap, it will then receive a ⅜ in. screw.

Sometimes when the drawing is sent to the shop it is found that parts do not fit well or are out of size so that a change in some dimension is necessary, the old one is often erased and a new one inserted without any record being made for future reference.

Such drawings should be marked "revised" and by adding a note near the figure altered, much time is often saved in the pattern shop if the pattern is to be changed too.

Suppose that on a drawing the dimension read 14½ in. and it was changed to 16½ in., it would be better to write 14½ in. alt. to 16½ in or to scratch out the 14½ in. and write in the new, either below or to one side of the old figure as shown in Fig. 4.



Then the old and new dimensions can be seen at a glance.

The dimension lines should be thin lines, either black or colored, but the arrow-points and figures look best in black and should be made with a common writing pen, and this part of the drawing should be as neat as possible. Many a good drawing is spoiled by poor lettering and figuring.

The amount of taper on an object may be indicated by drawing a triangle as shown at (e) Fig 2 or at (f).

The triangle at (e) shows a taper of 1 in 32 *on the diameter*, that is, the diameter varies at the rate of 1 in. in 32 in. or ¼ in. in 8 in.

The triangle (f) shows a taper of 1 in 64 *on the radius*, that is the radius varies at the rate of 1 in. in 64 in., or ¼ in. in 16 in.

In getting up the drawings for a complicated machine, the best way is first, to determine the chief dimensions, then make a general drawing of the whole, leaving out some of the smaller details.

Then make working drawings of all the parts or details as they are often called, taking the larger and most important ones first. Lastly, finish up the different views of the complete machine so to see that all parts fit in properly.

The appearance of the general drawing is sometimes improved by surface and line shading as described in a previous chapter, and in the detail drawing such section lining and notes should be put on as needed.

TRACINGS.

Tracings are copies of working drawings on some transparent material, usually paper or cloth.

If a piece of tracing paper or cloth is placed over a drawing, the lines

can be seen through it and can be reproduced thereon, this is usually done in black ink.

Tracings are often made from a pencil drawing and finished up much more completely than the drawing which is then laid away for reference or destroyed.

Nowadays, the tracing is seldom sent to the shops but a photographic production of it called a "blue-print" is used for all work outside the office. These are on paper with blue background and white lines and figures.

The process then is, first to make a drawing, then a tracing in good jet black ink, finishing it thoroughly as to dimensions, sections, etc., check it up to see that all parts are correct, make a blue print and send it to the shop, keeping the tracing for future reference.

Before the introduction of blueprints, drawings were nicely finished and even colored and sent to the shops, but if lost, there was no record of the work.

Sometimes the tracing is sent out on the work and the original drawing kept in the office but this is a poor practice.

Tracing cloth has its two surfaces finished differently, one glazed and the other dull and the opinion of draftsmen differ as to which side should be used.

Some claim that it is easier to work on the glazed side, that erasures can be made better on that than the dull side.

In using either side, it is found that the cloth when fresh treats the ink as if the surface was oily so that the common practice is to rub the surface to be used with a prepared chalk or other like substance.

In this course, it is suggested that the dull side be used and if erasures are to be made, they should be made with a very sharp knife or ink eraser, then rub the place with a piece of soap stone. This produces a surface nearly as good as the original and will usually take ink well.

To be continued.

CURRENT TOPICS.

In the Drafting Room.

The whistle blows a long, shrill blast
at seven in the morn,
Two draftsmen appear, but the last is
late on account of his corn.

They talk about their girls and the fun
they had last night,
While cigarette smoke about them
curls they sing with all their
might.

But hark a sound of footsteps is heard
to approach the door
Then everyone with a nimble bound
his board is leaning o'er.

A familiar face has entered, 'tis the
assistant superintend'.
All eyes on him are centered, silent
oaths at him they send.

But he cannot stay there always for
'tis a glorious day
And helloh! Here comes Charley to
while an hour away.

The morning sun mounts higher, 'tis
nearly nine o'clock.
What was that you said sir, be careful,
don't you knock.

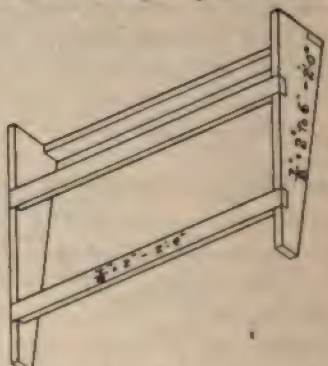
Our work is rather brain racking and
eight hours is enough,
If we're compelled to come at seven
two hours must be bluff.

To the Editor of "The Draftsman."

Sir:

There have been several references in recent numbers of "The Draftsman" to various methods of supporting a drawing board in a slanting position upon a flat top table and I am sending herewith a sketch of a still different one thinking that it might be interesting to draftsmen generally.

This stand, as shown by the sketch, consists of a light pine framework



about 2 ft. wide, 2 ft. 9 inches long, 2 inches high at the front and 6 inches high at the back. These dimensions give a convenient size to accommodate a 27 x 39 drawing board, and a slant about as steep as possible with scales and triangles sliding off.

By arranging the cross pieces a little differently and lining the frame with oil cloth or something else strong and light in weight, a handy receptacle for papers, books, and the like can be made, the drawing board itself forming the cover.

W.

Draftsman's Visit to New York.

I well remember one beautiful Monday morning in the early summer time. I had been to the Bronx Zoo on Sunday afternoon and to Coney that night, with a bunch of those good fellows, a mixture of Elks and Eagles, I believe. Well, on this ne'er to be forgotten day, I paid a visit to a large *plant*, it was in full foliage and among the branches disported several long-legged aquatic birds of the *crane* variety. I asked why they were not down wading in the water, but was told they were *electric cranes.*

The first thing that struck my fancy in the machine shop was a *dog* in a lathe turning around at a two-forty clip. I asked the operator what sort of a dog he was. He said it was a revolutionary dog, and although so old could stand a pretty good *feed*, but when the feed was on it always had its tail in the *plate*. The way it was *chasing* a large screw around, I thought it had its tail in its face. When it stopped one could see it was in the *face-plate*. It looked like a setter, for it certainly was set on the work.

I kept an eye on a large *spider* for fear he was dangerous, but didn't see a *crab* coming down the line with a load of *fish-plates* until I got pinched by him between a *pair of horses* and a large *bull-ring*. There was several tons of *pig* on that pair of horses, they were heavily built, and as there was no *scrap* in the bull-ring I ducked that way. Just then one of those blame cranes flew up from the wharf and dropped a *clam-shell* right over me. It certainly closed up like a clam and started off with me. Now I never did like clam soup but seemed to be in it just the same. I was thankful to have gotten away from the bull-ring, but when that shell opened I landed right on a *bull-riveter*. Now, just because I dropped from a clam-shell didn't say I was bullion, but I nearly got in the dies just the same.

There was an awful noise out there and Miss *Dolly Barr* was trying to hold an animated conversation with a pneumatic riveter. He struck her fancy so hard and fast that she said he was too warm a proposition for her and not being a *holder-on* dropped it. I saw a *monkey wrench* a nut around, but it must have been too hard a nut for him to crack as he bolted, slipped off and fell to the floor.

There were several *old men* drilling up and down the shop. I addressed one but he said he wasn't stationary, they had to bolt him to work; he was stamped just the same. I asked him what his favorite drill was, but just then a ram butted in and interrupted the conversation. It seems this ram was part of a slotting machine. I asked if it was a nickel machine and was informed that nickel was in the steel. Asking if it was tempered proved very foolish, for the wind it knocked out of me certainly was not tempered to a shorn lamb.

I was curious to know what was in a tank and was told it was one of Heinz's 57 varieties. They would not let me try it, however, as they didn't pickle things when they were done. I felt pretty well done and took an L for home but they turned the Y on me. That sobered me up. I returned my pass at the office and got out.

A BUGHOUSE.

GENIUS.

"Genius, that Power which dazzles
mortal eyes,
Is oft but Perseverance in disguise;
Continuous effort, of itself, implies,
In spite of countless falls, the power
to rise.

"'Twixt failure and success, the
point's so fine,
Men sometimes know not when they
touch the line.
Just when the pearl was waiting one
more plunge,
How many a struggler has thrown up
the sponge.

"As the tide goes clear out, it comes
clear in;
In business, 'tis at turns the wisest
win.
And oh, how true when shades of
doubt dismay;
'Tis often darkest just before the day.

"A little more persistence, courage,
vim,
Success will dawn o'er fortune's
cloudy rim,
Then take this honey for the bitterest
cup—
There is no failure save in giving up.

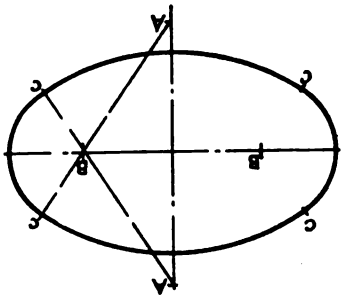
"No real fall as long as one still tries,
For seeming setbacks make the strong
man wise.
There's no defeat, in truth, save from
within;
Cnless you're beaten there, you're
bound to win.

HENRY AUSTEN.

The National Messenger.

MEETING POINT OF CURVES.

When two curves are drawn in on a drawing, they should be joined neatly, and to do this each should stop at a certain point. Suppose as in the figure, the centers of the arcs of circles used are at A & B. To help the work where part could be inked in, the



arcs about B could be drawn in pencil and pencil lines drawn from A through B, cutting the arcs, say at C. These will be the ends of the arcs, so that the ink arcs about A as a center may then be drawn to C.

EASY LESSONS IN ARCHITECTURE.

This little work is compiled with the view of creating a taste in the mind of the young for the noblest of the arts—architecture.

Beginning with the early history of architecture, it traces the styles through to modern types, and it is done in an easy and careful manner.

Nearly every page contains an illustration and which are referred to in the text, which is entirely free from mathematics.

This book is published by The Industrial Publication Co., 16 Thomas St., New York, N. Y., and is sent postpaid for fifty cents.

Some Directions to Students used at Kalamazoo Manual Training School.

Whenever a drawing is to be tinted the paper must be shrunk down so that it will not wrinkle when wet and remain wrinkled after it has been finished. Place the paper on the board with face side up. Fold up about ⅝ to 1 inch of the margin on all sides so that the paper will resemble a shallow box. Turn the paper over so as to rest on the turned up edges. With a clean sponge and water dampen all of the surface of paper except the turned up edges which are to receive the paste, glue or mucilage. Then wipe off all of the water from paper and turn right side up. Rub down and stretch the top and bottom edges of paper first. Be sure and leave no wrinkles either in the edges or in the corners. The other edges are then treated in the same manner. The edges must be kept straight. If no wrinkles are left in edges or corners the paper will dry smooth. The paper muct be allowed to dry slowly; if placed in sun or heated it will get too dry and wrinkle when exposed to an ordinary temperature. To avoid streaks in paper, use clean water and sponge and wipe off all water, and have board flat when placed to dry. Be sure no water gets on the margin of paper used for paste and that no paste gets on the middle of drawing board or inside the dry edges of paper, to cause trouble in cutting off the paper when the drawing is finished. In large drawings both sides of the paper are wet but it is best not to wet the face when stretching the paper because the surface is lost and then the paper soon becomes soiled. Do not attempt to draw on paper until dry and smooth.

A drawing that is to be tinted must be made carefully with lead pencil and if possible without erasing, the surface to be tinted if rubbed or scratched will be apt to show when finished. The drawing can be tinted without inking in if all lines that are not to be inked are removed, a lead pencil line when wet becomes almost indelible and difficult to erase. If the drawing is *Inked* in first the paper must, when the ink is dry, be washed with plenty of clear water to remove any superfluous ink from paper that would cause dirty colored tints in the drawing. Do not rub paper hard with sponge or the surface of paper will be injured.

When the surfaces are to be tinted the drawing board can be slightly inclined in one direction so that the color may flow easily in one direction. The surfaces can be wet with clear water before the color is applied and more even tints will then be secured than if the color is applied at once to the hard, dry surface of the paper. The most common way is to use a double end brush, the large end to hold clear water for blending, the small end to hold the color. With considerable color in the brush but not nearly all it will hold, commence at the top of the surface to be tinted and follow it carefully with the first stroke. Before the color dries at the top, lay on the color below by moving the brush back and forth, using enough color in the brush so that it will flow gradually, with the

help of the brush towards the bottom. The lines must be followed carefully at first, and the brush not used twice over same place while surface is wet or streaks will form. Do not paint the colors on, but allow them to flow quite freely after the brush.

It is best to protect the drawing with a sheet of paper and only expose the surface needed. Clean blotters are useful in many ways, a blotter with ink on it should never be used when tinting surfaces as the ink might ruin the colored surface.

Be sure your brushes are clean and never put a brush away until cleaned and with the hair drawn to a point in proper condition to dry. Tints must be mixed with clean water, kept stirred up and from dust. Try to tint a surface with one brush full of color if possible. If a heavy color is desired it is best to apply a lighter shade first and a darker afterwards.

In the color boxes will be found the *Primary Colors, Red, Yellow, Blue.* To produce the *Intermediate Colors: .Orange,* use red and yellow; *Violet,* use red and blue; *Green,* use yellow and blue. To produce *Black* use stick India ink in place of bottled ink or red, yellow and blue in equal proportions. *Brown,* use yellow, blue and most of red; *Grey* use red, yellow and most of blue; *Terra Cotta* or *Brick,* use red, yellow and less blue.

The following tints are suggested:

Cast Iron, India ink, blue and red; Wrought Iron, India ink and blue; Steel, blue; Glass, green; Brass, yellow and red; Copper, red and less yellow; Stone, India ink and blue; Brick, or Terra Cotta, red, yellow and less blue; Wood, yellow or brown; Water, blue or green; Earth, yellow, blue or brown.

Colors can be made more permanent by adding a little Gum Arabic to the water when mixing but little should be used, a little blue will help black ink and remove the greyish tint.

Summer School.

Courses in the following subjects will be given by instructors of Case School of Applied Science, Cleveland, Ohio, beginning June 21st, and continuing for six weeks:

CHEMISTRY.

General Chemistry, Qualitative Analysis, Quantitative Analysis.

MATHEMATICS.

Elementary Algebra, Plane, Solid and Spherical Geometry, Advanced Algebra, Trigonometry, Analytic Geometry, Calculus, Roofs and Bridges.

MECHANICAL ENGINEERING.

Heat and Steam, Mechanism, Machine Design, Joinery and Pattern Making, Iron Work, Machine Drawing.

PHYSICS.

Elementary Physics, General Physics, Physical Laboratory, Teachers' Course.

MODERN LANGUAGES.

Elementary German, Advanced German, Advanced French.

MINERALOGY.

APPLIED MECHANICS.

Statics and Strength of Materials, Dynamics, Hydraulics, Testing Laboratory, Descriptive Geometry and

Drawing.

These courses will be of especial value to teachers who have been called upon to take charge of instruction in elementary science and to those who intend to enter the institution in the fall but have been unable to make complete preparation, as well as to those students who, on account of illness or other cause, are deficient in their regular work.

In each course personal instruction will be given adapted to the individual needs of the students, and persons desiring courses other than those mentioned can undoubtedly make satisfactory arrangements upon application.

In order that any course may be given a minimum number of students must make application before *June 14th.*

The laboratories will be open all day and the same facilities are offered for practical study during the summer as are open to students during the school year

A brief description of the laboratories and their equipments will be found in the general catalogue

TUITION AND FEES.

For each course, excepting Elementary German, the tuition will be $25.00. For Elementary German (double course) the tuition will be $40.00.

Students in the Chemical Laboratory will be charged $5.00 for materials used and will be required to deposit $5.00 against breakage in addition to tuition.

Tuition and fees must be paid to the instructor in charge of the department, upon registration, June 21st.

Inquiries about courses should be addressed to the instructor in charge. For catalogues and information about the institution. Address,

CHARLES S. HOWE,
President.

Germany and America Compared

The following is a comparison of the German and American trains, which shows manifestly to which country belong the honors of the fastest trains:

	German.	American.
Whole number of trains averaged	321	303
Number of lines showing trains having an average running speed above forty miles per hour	22	26
Number of trains having an average journey speed above forty miles per hour	18	90
Total number of trains having an average ruuning speed above forty miles per hour	45	122
Number of trains having an average running speed above fifty miles per hour	3	12
Number of trains having an average running speed from forty-five to fifty miles per hour..	4	36
Number of trains having an average running		

speed from forty to forty-five miles per hour	38	74
Number of groups showing when all trains of group were averaged, a journey speed above thirty miles per hour..	3	22
Number of groups showing when all trains of group were averaged, a running speed above thirty-five miles per hour	3	18

In summing up the evidence it may be said that to America belongs the fastest trains, but at the same time European trains seem to have the advantage over us on the middle distance travel, and then, again, in the long distance journey, this country appears to excel Europe.

The Simplex Trimmer.

The Simplex Trimmer is designed to trim wall paper, drawings, blue prints, etc.

It is very light and durable and will cut true to the straight edge at all times.

By means of a straight edge, drawings and blue prints could be easily trimmed.

An outfit consists of a Trimmer, Straight Edge and Zinc Strip and prices may be obtained by writing Webster & Parks Tool Co., Springfield, O.

Charles S. L. Baker, a negro of St. Louis, claims to have perfected, after twenty-three years of labor, a process for generating heat and power by friction without combustion. The heat produced is used in the form of hot air, hot water, or steam, and Mr. Baker claims that the particular motive power used in creating the friction is not essential. It may be either water, wind, gasoline, or any other source of energy. The most difficult part of the inventor's assertions to credit is the statement that his system will light or heat a house at about half the cost of methods now in use. The business world will accept that claim only after complete demonstration, and scientific authorities will be equally incredulous.

Perpetual Motion Tragedy

worked at it for forty years, and there is no spring in it, and it does go.'

"So they got an ax and chopped it up, and there was a great silence, for there was no spring. And the old man picked up the fragments and went away with the tears rolling down his face. And he died soon after."

Books Reviewed.

The firm of Winn, Milmore & Porter, engineers, designers and draftsmen have moved from Unity Building to Stock Exchange Building, Chicago, Ill. They publish a chart of gauge numbers and the nearest decimal equivalents which should hang beside every draftsman's desk.

Architects and draftsmen who have specifications to prepare will appreciate the Improved Specification Blank for Masons, Carpenters, Tinners, Plumbers and Painter's work, which is prepared by Palliser & Co. and published by the Industrial Publication Co., 11 Thomas St., New York, N. Y. Price, 15 cents.

Bevel Gear Tables—a collection of tables and necessary explanation to enable anyone to figure bevel gears without the use of trigonometry.

Few people who have once used this book for obtaining the necessary data for a bevel gear will ever again resort to the slow and tedious method of figuring them.

Beginning with Tooth Elements and continuing through the construction and calculating of the bevel gear, the book is clearly illustrated and printed on coated paper, written by D. Ag. Engstrom, cloth bound, 5½ x 8 in. pages, postpaid, $1.00. The Derry Collard Co., 257 Broadway, New York.

An album of St. Louis and the World's Fair, size 10 x 15 in., with 185 illustrations, including a bird's eye view of the Fair, size 23 x 29 in., will be sent to any address on receipt of 31 cents in stamps. Geo. A. Zeller, 185 4th St., St. Louis, Mo.

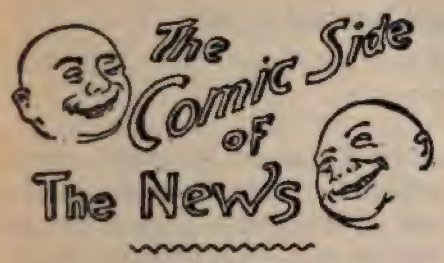
This has been called the "age of illustration" and the writer of "Rogers Drawing and Design" has certainly kept this in mind, while preparing this splendid work.

The helpful value of a teacher or instructor is a blessing to a student but a well illustrated and written book will often almost suffice when the young man is determined to learn.

The work is comprised of some twelve divisions of which the first five take up the preliminary details, including working drawings, tracings and blue printing. The divisions from six to ten inclusive are devoted to Machine Design, Transmission Methods, Metal Working, Machinery, Engines and Boilers, Electrical Machines, etc., etc.

"Part Three" contains a treatise of drafting instruments and their uses and a large number of tables of value to the draftsmen and designers.

The book is beautifully finished, contains nearly 500, 8 x 10 inch pages, nearly every one of which has an illustration, cloth binding, gilt edges. Price $3.00, published by Theo. Audel & Co., 63 5th Ave., New York, N. Y.



UP IN THE WORLD.

"There is every opportunity for young men to rise in the world in this age," said Old Jilson, speaking of flying machines.

IN THE AIR.

Friend—Did you raise—

Inventor—Raise what?

Friend—Your airship scheme?

Inventor—Oh, I haven't been able to raise anything but money so far.

AN IMPRESSION.

"The Japanese are wonderfully bright people."

"Yes," answered the plodding person. "I should think they would have to be in order to spell and pronounce their own names."—Chicago-Record Herald.

THE TROUBLE.

"How often do we find that great inventors are allowed to go unrewarded and unrecognized!"

"Yes," answered Senator Sorghum, "the trouble about inventors is that they insist on inventing machinery instead of ways to make money."—Washington Star.

In China a mile is anything from a quarter of a mile to a mile and three-quarters, according to the province in which it may happen to be.

Editor Draftsman.

Your April number contains articles by both Mr. Florence W. and Mr. M. C. Hurd, who endeavor to show the error in Mr. Babbitt's construction "Something for our Geometrical Friends" in the December number. Both are wrong in saying that lines KE and CE are not equal.

Mr. Florence W. says, "The error is found in the assumption that KE equals CE." Now in the original article, no such assumption was made because line KE and CE are positively made equal by construction. He then goes on to say, draw square ABDC, bisect BD and erect a perpendicular in G. making GE equal to the distance shown in the original. The original was a geometrical sketch and not a drawing therefore it is incorrect to assume that line GE should be the same length as was shown. Point E is the intersection of the perpendicular bisectors of lines AC and KC and not where it was shown. It was a matter of convenience that it was so placed.

Plans have been filed in Chicago for an Iroquois Memorial Emergency hospital, to be erected in that city, and to provide and maintain an institution in memory of the victims of the Iroquois theater fire on Dec. 20.

Scientific authorities continue to look more to mechanical devices, heavier than the atmosphere, for progress in aerial navigation, rather than to airships sustained by gas and made, with their passengers, as light, or nearly as light, as the air they displace.

School for Artisans,

The College of Engineering of the University of Wisconsin, begins June 27th.

Courses of study are offered in the following subjects:

1. *Steam, Gas and Other Heat Engines.*—Lectures on the theory of heat, the operation and methods of testing steam, gas and air engines, boilers, compressed air and refrigeration plants.

2. *Applied Electricity.*—Theory of direct and alternating current dynamos and motors, the operation and methods of testing electrical machinery, batteries, transformers and other apparatus, phatometry and calibration of instruments.

3. *Mechanical Drawing and Machine Design.*—Elements of applied Mathematics, courses in Mechanical Drawing and Machine Design adapted to the preparation of the students.

4. *Materials of Construction, Fuels and Lubricants.*—Lectures on the properties of materials accompanied by laboratory tests; lectures on fuels and lubricants with laboratory tests on the heating value of coals and efficiency of lubricants.

5. *Shop Work.*—Practice with hand tools, wood and metal working machinery, and in blacksmithing and pattern making.

The instructional force is taken from the regular faculty of the College of Engineering, and the entire laboratory and shop equipment belonging to the College is used by the students in the Summer School.

This school offers to those unable to take a regular four years' course an opportunity of obtaining practical working knowledge of the methods of testing and the use of instruments, together with such theoretical principles in each case as the nature of the subject and preparation of the student may permit.

A bulletin describing the work of the School for Artisans in detail will be sent on application to

FREDERICK E. TURNEAURE,
Madison, Wis.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study,

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Machinery Hall, World's Fair.

Courtesy of "Tengwall Talk"

MECHANICAL.

An Important Test of Elliptic Springs.

BY S. A. BULLOCK.

The object of this test was to ascertain the greatest possible set this spring would receive under successive applications of light, heavy and excessive loads; and also to determine whether 106,000 pounds per square inch is an efficient fiber stress for the working load of plate springs.

Dimensions of spring before test:

Free height over bands	13¾ ins.
Free height between bands	6¼ ins.
Lenghth of spring over all	31½ ins.
" center to center	29½ ins.
Plates	3½x5-16 ins.
Numbar of springs per set	4
Number of plates per spring	9
Style of spring	Double elliptic

During the first six tests the loads were gradually applied and released by a screw testing machine, traveling at the rate of 3 ins. per minute. But in the last test, as shown by curve C (Fig. 5), an hydraulic testing machine was used. The weight-beam was so adjusted that the load could be partially released, and then suddenly forced band to band by moving the lever up and down by hand. For the use of their testing machines we are indebted to the Baldwin Locomotive Works.

This last test was made on a different spring of the same class as the one used in the first six tests, and we have shown it in Fig. 5 for the sake of comparison.

The spring steel was furnished by the Crucible Steel Company of America, and made into springs by the Standard Steel Works, from whom we have the following chemical analysis:

Carbon (ombined)	1.01	per cent.
Manganese	.310	" "
Phosphorus	.033	" "
Sulphur	.025	" "
Silicon	.170	" "

The first test (Fig. 1), consisted in giving 383 successive applications of the light load of 12,500 pounds, equivalent to a fiber stress of 91,400 pounds. (We have considered L one-half the length of spring under load P, to be equal to 15 ins.)

It is interesting to note that after the first application of the light load, and up to a certain number of applications (207), the spring grew 3-16 in. in the loaded height, the free height remaining constant. After this limiting number of applications, the successive applications of the load produced no further change.

The reason for this growth of spring, or increase of efficiency, is due to a decrease of friction between the plates. For in the manufacture of plate-springs there is always scale between the plates and the frequent application and release of this load pulverizes the scale, which then acts as a lubricant, and reduces the friction.

The second test (Fig. 2) consisted

of 12 applications of 14,500 pounds, or a fiber stress of 106,000 pounds, producing a set in the free height of minus 1-16 in. and a set of minus 1-32 in. in the loaded height.

The third test (Fig. 2) consisted of two applications of 20,000 pounds (fiber stress 146,000). No additional set was found.

In the fourth test (Fig. 3), the

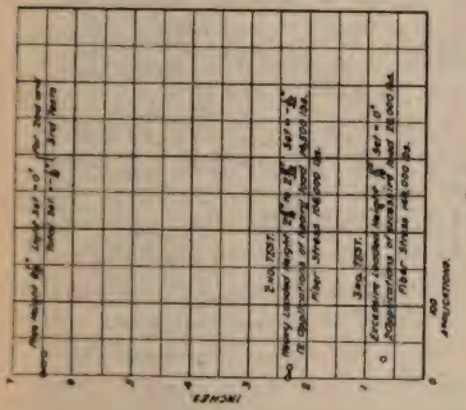


FIG 2.

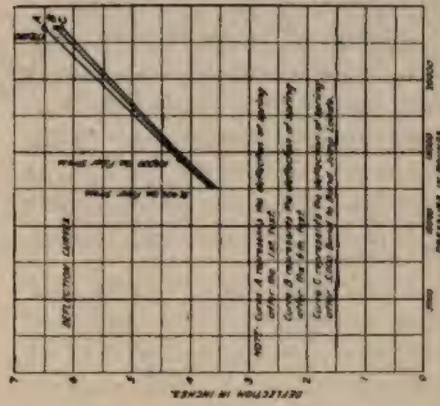


FIG 5.

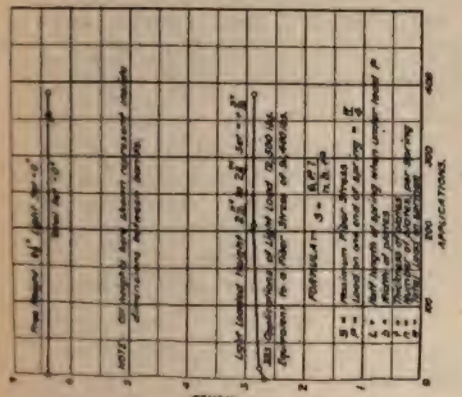


FIG. 1.

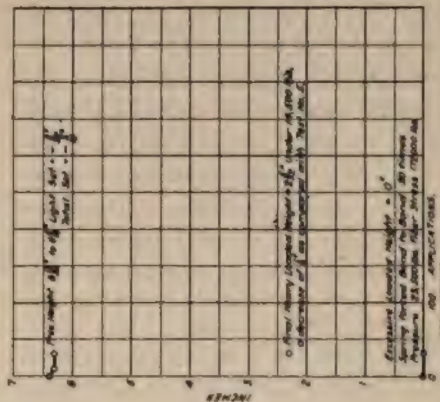


FIG 4.

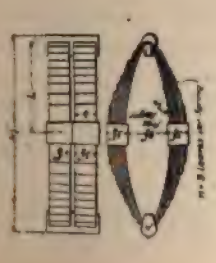


DIAGRAM OF SPRING.

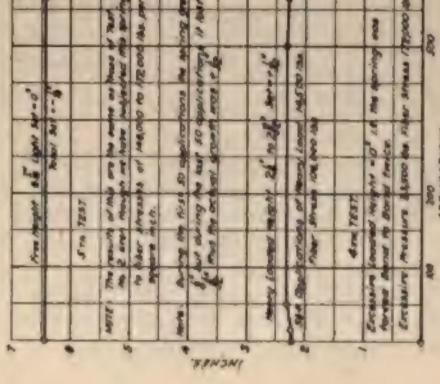


FIG 3.

spring was forced band to band twice, requiring an average pressure of about 23,500 pounds, or a fiber stress of 172,000 pounds per square inch. No appreciable set was discovered.

The fifth test (Fig. 3) consisted of 564 applications of the heavy load of 14,500 pounds, producing a fiber stress of 106,000 pounds. During the first 50 applications the spring grew ⅛ in., but lost 3-32 in. during the last 50 applications. Thus the actual growth was 1-32 in., the free height remaining constant.

The fifth test (Fig. 3) consisted of forcing the spring band to band ten times, then applying the test load of 14,500 pounds. This operation was repeated three times.

The first average pressure required to bring the spring band to band was 23,000 pounds, the successive average pressures required an additional 500 pounds to bring the spring band to band (i. e., 23,500, pounds or fiber stress of 172,000 pounds). The free height additional set was minus 3-32 in. The total light set was minus 3-16 in.

CONCLUSIONS.

Now, from these six tests, we note that 30 band to band applications produced a total set of minus 3-16 in. In the jump test between the 25th and the 5010th application the additional light set was minus 3-32 in. Accordingly, we may infer that the first spring could not receive a total set greater than minus 9-32 in., or that during the life of the spring, curve B (Fig. 5) would never fall below curve C.

Accordingly, it is evident that 106,000 pounds per square inch is allowable for the working fiber stress. The maximum allowable fiber stress can only be determined by more exhaustive experiments upon this subject.

Since all springs are at times subjected to excessive pressures which tend to produce a deformation from which the spring can never recover, we would suggest that when plate springs are tested they shall first be given two applications of that load which would be equivalent to a fiber stress of 146,000 pounds per square inch. Such a pressure to be quickly applied and released, the object being to relieve the spring of most of its set while under the testing machine, and thus insure ourselves against the annoyance of having the spring receive any permanent set when under the car.

—*Am. Engineer and R. R. Journal.*

On Machine Design.

The Editor of the Draftsman,
Cleveland, Ohio.

Dear Sir:—I would like to say a word or two on the subject of the article on "Machine Design." I doubt very much whether the graphic method of solution given on page 207 is quite reliable. I would ask, "What is there to prove in a case like this one (thickness of Babbitt) that a *straight* line drawn through the values for a large and a small machine will give correct values for intermediate sizes of machines?" If *three* sizes were "carefully designed" by computation of stresses, etc., and these being plotted, indicated a straight line to be the solution of the intermediate size, then certainly such straight line would equally give the values of other

intermediate sizes, but if the plotting of the three calculated sizes indicated a *curve* line as giving the thickness of babbitt, then the value for all other intermediate sizes must be taken from this curve and not from the straight line.

Further, the very fact that the given values calculated from two sizes of machines, viz.:

5 in. bearing, 3/8 in. babbitt, and 2½ in. bearing, ¼ in. babbitt, are so disproportionate, is sufficient of itself to at once show that a straight line is not the correct solution of the thickness of babbitt for other sizes.

Again, the fact that the graphic method as shown by the straight line, Fig. 1, gives ⅛ in. thickness of babbitt as being necessary for a shaft having *no* diameter at all, at once proves that a curve line and not a straight line, is the proper solution of the problem. We have three points given from which the curve may be easily laid out or calculated, namely: —

Diameter	o',	thickness	o"
"	2¼"	"	¼"
"	2"	"	3/8"

As to Misleading Information, page 218, what do you say to catalogues of Water Wheels or Turbines which give an efficiency of over 100 per cent.? One has to be very careful in accepting everything as gospel which is stated in a catalogue.

"Instruments for the Construction of Equivalent Geometrical Figures" by Jeremy C. Willmon, page 234. Please note that the "Triangle" described in this article is an exact copy of the triangle designed by me and copyrighted by me in 1892, a full description of which was given in "The Compass," Vol. II, November, 1892, page 64. This triangle was called the "Pi" Triangle, and was at once placed on the market. There is nothing new under the sun.

Very truly yours,
WM. COX.

Curious Facts.

The importations of pig tin last year were 68,000,000 pounds, against 7,000,000 in 1890.

Japanese warships equipped with wireless telegraph apparatus have sent and received messages to and from Japan at a distance of about 50 miles.

Twelve million pounds' worth of leather is required every year to provide boots and shoes for the inhabitants of Great Britain.

In honor of Peter Henlein, the inventor of the watch, a monument is to be erected at Nuremberg.

Leather waste is no longer wasted. Manufacturers use it in a compressed form instead of iron to make cogwheels.

If a man could use his legs proportionately as fast as an ant he would travel somewhere about 800 miles an hour.

Farm machinery saved in the planting and gathering of last year's crop in the United States $700,000,000.

A wine cask has just been built in California to hold 97,000 gallons. Its iron hoops weigh 40,000 pounds.

ARCHITECTURAL.

Beams and Joists.

BY GEORGE H. BLAGROVE.

Rolled iron beams are so much used in modern building that I am emboldened to draw attention to a few little points in connection with them and with construction attached to them, which are not always thoroughly understood or borne in mind by workmen.

First, as regards the strength of a rolled-iron beam. I have referred in a former article to tables showing the strength of rolled iron, which have been published by various firms of manufacturing engineers. Such tables are, as I have already stated, very handy for reference. Yet it will be as well, perhaps, to explain a simple method of calculating the strength of an ordinary rolled-iron beam, if only to show that there is nothing very complicated about such calculations, as too many people are apt to suppose. The usual rule is to take the sectional area of the bottom flange in square inches; multiply it by the total depth of the beam in inches; multiply this again by seven and divide the result by the span of the beam in feet. The result of this gives the number of tons required to break the beam if placed upon it in the middle of its span. If the weight is to be evenly distributed over the whole beam, instead of being concentrated in the middle, twice as many tons will be required to break it — that is to say, that in multiplying we should use the number fourteen instead of seven. In calculating the sectional area of the bottom flange this is taken up to where the straight part of the web commences, the required sectional area being the lower portion, shaded in Fig. 1. Rather a troublesome job, it may be thought, to calculate the number of square inches in such an irregular form with any degree of nicety. But a very simple rule, which ought to be more generally known, may come to our assistance here. In rolled-iron beams or bars of any uniform section three times the number of pounds per foot run, divided by ten, will give the area of the whole section in square inches. Referring to Fig. 1, we can easily measure the sectional area of the straight part of the web, which is unshaded, and deducting this from the whole sectional area, found by the preceding rule, the remainder is the united areas of the two flanges shaded in the diagram. These being usually equal, we have only to take half the result of our calculation for the required sectional area of the bottom flange.

The permanent load upon a rolled-iron beam should not exceed one-fourth of the weight required to break it, and it should not be tested to more than one-third of it. If any specimen

of the iron has been broken, this gives us an opportunity to judge of its quality. The fibers of the metal should be long and silky, and the grain should not be coarse.

For constructional purposes it is often necessary to make holes in iron beams for bolts to pass through. The holes should be drilled, for if punched their sizes are apt to be unequal, besides which the metal immediately surrounding a punched hole is always more or less weakened. Much depends upon the positions of the holes, if the strength of the beam is to be economized. Remember that when a beam is supported at the ends and loaded from above it is subjected to two kinds of strains — one tends to stretch or tear asunder the lower part of the beam and the other tends to compress or crush the upper part. About midway between the top and bottom of the beam is what engineers call the neutral line, where the pulling and pushing strains are supposed to balance one another; and at this part the metal remains practically unaltered in form, however much the beam may bend, so long as it does not break. It is evident that the metal at the top of the beam is most severely compressed, while that at the bottom is most severely stretched; and the safest position for holes is at or near the middle, where they will least detract from the strength. Holes drilled in the lower part tend to widen by stretching, and obviously weaken the beam by reducing the resistance to tension; but holes drilled in the upper part tend to become reduced in size by compression, and they do not, therefore, weaken the beam, provided that they are completely filled by the bodies of iron bolts, which resist compression, preventing the holes from being reduced in size. Hence, if we have any choice in arranging the positions of holes in iron beams we should place them in the middle or upper part by preference. In calculating the strength of riveted girders, engineers always deduct the space traversed by rivet holes in the bottom flange, and this rule should be followed in respect to any bolt holes in rolled iron beams.

In ordinary wood-joisted floors, divided into spans by rolled-iron beams, there are more ways than one of connecting the joists to the iron beams. Many persons adopt the method shown in Fig. 2.


FIG. 1

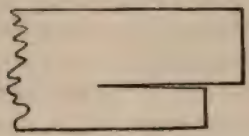


FIG. 3

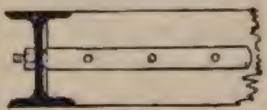


FIG. 5

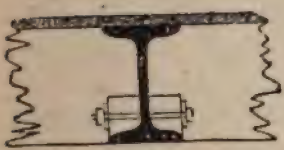


FIG. 2


FIG. 4


FIG. 6

IRON BEAMS AND JOISTS.

Here a plate rests upon each bottom flange, being either bolted down to the flange, or, for better economy in drilling and bolting, bolted right through the lower part of the web. This drilling through the lower part of the beam is objectionable, as already explained. Besides this the joists are notched out for the plates, which weakens them terribly; indeed, it may be said that if an 11-in. joist is notched out 4 in. on its lower end, its strength is almost reduced to that of a 7-in. joist, so serious is the result of cutting away the bottom fibers of the wood, which resist the stretching strain. Under such circumstances the strain upon the joists is very liable to produce a split like that shown in Fig. 3.

A better method of attaching joists to an iron beam is by bolting a piece of timber against each side of the beam, for the entire depth between the flanges, and by tenoning the joists into these timbers on both sides, as shown on the left side of the diagram in Fig. 4. But there is considerable labor involved in cutting the tenons and mortises, besides which there is sometimes a practical difficulty in getting the joists into position. On the right side of the diagram the ends of the joists are simply cut to fit in between the flanges, each joist taking its bearing upon the bottom flange. By this means the joists obtain a more solid and even bearing (for the tenons may shrink unequally, throwing all the pressure upon one shoulder), and blocks of wood, cut to the proper length, are bolted in between the ends of the joists to prevent them from moving laterally.

Sometimes it is desirable for joists inserted against the sides of an iron beam to act as ties. This is especially the case when the beam is used as a shop breastsummer, the joists being required to assist in holding in the front wall of the building. This may be done by means of a strap-bolt attached to about every second or third joist by means of small bolts or screws, as shown in Fig. 5.

The form of such a belt, which should be all forged in one piece, will probably be understood from Fig. 6, where the bolt is seen in plan.

Another way of securing a tie is by means of L-straps, one arm of the L being bolted against the joist and the other against the web of the iron beam, or against the timber bolted to the web.

In cases like Fig. 2 and Fig. 4 the ceiling beneath and the floor above are easily managed. First, as regards the ceiling. Whether the under sides of the joists are flush with the bottom of the beam, or drop below it, all we need do is to fix the laths diagonally where they have to cross the beam. Then, as regards the floor. If the tops of the joists are flush with the top of the beam, as in Fig. 2, a floor board of sufficient breadth will lie upon the top flange of the beam, having each of its sides nailed or screwed into the ends of the joists; but if the tops of the joists are above the top of the beam, as in Fig. 4, fillets of wood are placed upon the top flange to receive the floor boards, and are either attached to the flange by means of screws or are nailed sideways against the joists, as shown in Fig. 4.—*National Builder.*

Glass houses of a very substantial kind can now be built. Silesian glass makers are turning out glass bricks for all sorts of building purposes.

Home Study.

Use of Logarithms.

R. P. KING.

Logarithms are regarded by many machine designers as a bugbear, who immediately "pass up" all formulas containing them, while the usefulness of logarithms as a labor-saving device is neither understood nor taken advantage of as much as should be. In all my drawing room experience, I have seen but two or three machine designers who used logarithms in their calculation, except where absolutely necessary.

For the benefit of those designers who have had the advantage of high school algebra, but who have not fully understood the use of logarithms, I shall briefly outline the theory by which their use is mathematical. There are some minds that hesitate to accept anything mathematical that is not fully proved; such men will find the successive steps proved to their satisfaction. However, as there will be some who do not care to follow a course of algebraic reasoning, I will inclose the "letter" demonstrations in brackets, and they may be omitted if desired without losing the practical advantages of using logarithms.

There are at present in use two systems of logarithms. The natural (or hyperbolic) are used in analytical calculations and investigations, and are always denoted by the sign log .

The Briggs or common logarithms are, as the name denotes, the ones commonly used in every-day work. Where-ever the sign log appears, the common logarithms are meant.

Logarithms are a comparatively recent discovery, being invented by John Napier during the first part of the 17th century. Napier was a Scotsman, born near Edinburgh 1550, and was an inventor and mathematician. He brought out his system of natural logarithms (often called the Naperian system) in 1614. No sooner did this work fall into the hands of John Briggs, professor of mathematics in Gresham College, London, than he began the investigation which resulted in the system of logarithms that bears his name.

Definition.— The logarithm of a number is the exponent by which a fixed number, or base, must be effected in order to equal a given number. This definition is perfectly general, and any number (with the exception of unity) may become the base of a system of logarithms. If we assume 3 to be the base and write $3^2=9$, then by definition the log. of 9 is 2. Similarly the log. of 27 would be 3 under such a system, because $3^3=27$.

Before proceeding further, let us review for a moment the laws governing the theory of exponents, for upon these five laws hangs the theory of loga-

rithms.

$$a^m \times a^n = a^{m+n} \quad (1)$$

$$\frac{a^m}{a^n} = a^{m-n} \quad (2)$$

Cor. I $a^0 = 1$

Cor. II $\frac{1}{a^n} = a^{-n}$

$$(a^m)^n = a^{mn} \quad (3)$$

$$(ab)^m = a^m b^m \quad (4)$$

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m} \quad (5)$$

These laws hold good for any exponent, either negative or positive, integral or fractional. They may be readily verified by referring to any work on algebra.

If $a^x = n$, then by our definition, x is the log. of n. Substituting in the equation $a^x = n$, letting a = 1, we have $1^x = n$ ∴ $x = \log_1 n$. But as $1^x = 1$, the equation will hold only when n=1.

As 1 is the only number of which this fact is true, it will be readily seen that 1 is the only number that may not become the base of a system of logarithms.

Before taking up either of the systems in use, we should take a glance at some general propositions that are true for any system.

Log. of 1 is 0, for from Cor. 1 (2) $a^0 = 1$ ∴ $0 = \log_a 1$.

The log. of the base itself is 1.

$$a^1 = a \therefore 1 = \log_a a.$$

The log. of a product equals the sum of the logs. of its factors.

Let $x = \log_a m$ and $y = \log_a n$, then $m = a^x$ and $n = a^y$. Multiply the two equations together, $mn = a^{x+y}$ (1)

$$\therefore \log_a (mn) = x + y.$$

The log. of a quotient equals the logarithm of the dividend minus that of the divisor.

Let $m = a^x$ and $n = a^y$

$$m \div n = a^{x-y} \quad (2)$$

Hence $\log_a (m \div n) = x - y = \log_a m - \log_a n$.

The log. of a positive number affected with any exponent, equals the logarithm of the number multiplied by the exponent.

Let $m = a^x$ Now whatever value we assign to p $m^p = a^{px}$ $\log_a (m^p) = px = p(\log_a m)$

From the principles above, we see that by the use of logarithms, the operations of multiplication and division may be replaced by those of addition and subtraction, and the operations of involution and evolution by those of multiplication and division.

From these laws we may deduce the following rules:

1. To multiply one number by another; find from a table the logarithms of the two numbers and add them together. Find from the table the number corresponding to this logarithm, and it will be the product desired.

2. To divide one number by another; find from a table the logarithms of the dividend and divisor, and subtract the latter from the former. Find from the table the number corresponding to this logarithm and it will be the quotient required.

3. To raise any number to any power; find from a table the logarithm of the number; and multiply it by the exponent of the power. Find from the table the number corresponding to this logarithm and it will be the power required.

4. To extract any root of any number; find from a table the logarithm of the number and divide it by the index of the root. Find from the table the number corresponding to the logarithm and it will be the root required.

These rules apply to any system of logarithms.

The Briggs or common system of logarithms has for its base 10. From one general equation we have

$$\underset{a}{x} = n \text{ and } x = \underset{a}{\log.}\ n.$$

Writing the successive powers of 10 we have:

$$\begin{array}{lll} 10^0 = 1 & \text{and} & \log_{10} 1 \quad = 0 \\ 10^1 = 10 & & \log_{10} 10 \quad = 1 \\ 10^2 = 100 & & \log_{10} 100 \ = 2 \\ 10^3 = 1000 & & \log_{10} 1000 = 3 \end{array}$$

and from Cor. II. (2)

$$\begin{array}{lll} 10^{-1} = \frac{1}{10} & \text{and} & \log_{10} 0.1 = -1 \\ 10^{-2} = \frac{1}{100} & & \log_{10} 0.01 = -2 \\ 10^{-3} = \frac{1}{1000} & & \log_{10} 0.001 = -3 \end{array}$$

If the log. 1=0 and the log. of 10=1, then the log. of any number more than one and less than ten will lie between 0 and 1 and will be a decimal. In the same way the log. of any number between 10 and 100 will lie between 1 and 2, and may be represented as one plus a decimal.

If we represent the decimal by the letter d and the numbers by $1+n$; $10+n$; $100+n$, etc., we may form a general table of logarithms under the Briggs system.

$$\begin{array}{ll} \log 1 = 0 & \log 0.1 + n = 1 - d \\ \log 1 + n = 0 + d & \log 0.01 + n = 2 + d \\ \log 10 + n = 1 + d & \log 0.001 + n = 2 + d \\ \log 100 + n = 2 + d & \end{array}$$

This is the principle of the Briggs system of logarithms. The log. is divided into two distinct parts, the *characteristic* and the *mantissa;* the characteristic being an integral, either positive or negative; while the mantissa is a decimal, represented above by the letter d, and which is added to the integral part or characteristic. For convenience in the use of common logarithms, mantissas are always positive. Hence the logarithm of any number less than unity consists of a negative, characteristic and a positive mantissa. The sign — over a characteristic indicates that it is negative. Thus, $\bar{3}.851258$ is the log. of .0071 and corresponds to the expression $-3+d$ found in the general table of the Briggs system above.

The characteristic may be determined from the following rules:

1. If the number is greater than unity, the characteristic is positive, and numerically one less than the number of digits in its integral part.

2. If the number is less than unity, the characteristic is negative, and numerically one greater than the number of ciphers immediately after the decimal points.

And conversely: —

3. If the characteristic of a logarithm is positive, then the number will be greater than unity, and will have one more digit in its integral part than is numerically expressed by the characteristic.

4. If the characteristic of a logarithm is negative, then the number will be less than unity and will be separated from the decimal point by a number of ciphers one less than the numerical value of the characteristic.

Having thus found rules to guide us, both in the use of logarithms and in the method of determining the value of the number from the characteristic, we may turn to a table of logarithms and take up their practical applica-

tion.

The mantissa or decimal part of the logarithm is the part we find in the table.

Considerable care and thought have been expended in arranging logarithm tables to secure uniformity of position and main and subdivisions which we easily distinguished, and which afford resting places for the eye, so that the labor of looking up logarithms has been greatly lessened.

As Kent's Pocket Book is found on nearly every drafting table, so for this article we will use the table of logarithms found therein, although it is not the best table in use.

This table gives the logarithm of every number from 1 to 10,000, and by interpolating we may approximate to 100,000.

The log. of any number to 100 is given directly in the first division of the table, the characteristic and mantissa both being given: — For instance, the log. of 71 is 1.851258.

If the table had not been so constructed, but had started at 100, the log. of 2 — 3 — 4, etc., and of numbers having 2 digits, as 73 — 87, etc., would have been found under 200 — 300 — 400, etc., and under 730 — 870, the mantissa being the same in both cases, the characteristic only being changed.

The second part of the table is, however, constructed a little differently, the mantissa only being given. The mantissa of numbers from 100 to 1,000 being found in the second column under the figure 0 opposite their respective numbers; the characteristic being 2, from the rule already given. For instance, the log. of 585 is 2.767156; the log. of 956 is 2.980458, etc.

The logarithms of numbers between 1,000 and 10,000, and ending in 0 are found in the same way, but have a different characteristic. For instance, the log. 5850 is 3.767156 (note log. 585.), log 9560 is 3.980458, etc. The log. of 5854 is found opposite 585 in the column under 4, and is therefore 3.767453.

Referring to the general table on Page 12, where log. 1 + n = 0 + d, etc., if n is constant, then d is also constant; from this we may deduce the following:

Log.	.005854	=	3.767453	
	.05854		2.767453	
	.5854		1.767453	
	5.854		.767453	
	58.54		1.767453	
	585.4		2.767453	
	5854		3.767453	
	58540		4.767453	etc.

To find the log. of a number greater than 10,000, we resort to interpolation. For instance, log. 58547 is greater than log. 58540 and less than log. 58550.

	Log. 58550	=	4.767527
	58540	=	4.767453.
Difference	10		74.
	58547		
	58540		
Difference	7.		

If a difference of 10 = 74 at this point in the logarithm series, then a difference of 7 would be 7-10 of 74 or 51.8 (approximately).

	Log. 58540	=	4.767453
Add difference	7	=	51.8
∴ Log. 58547=			4.7675048.

The difference (74) may be found in the column "diff." opposite this number 585, and the proportion 7-10 = 51.8 is found below in the table of proportional parts, so the work of interpolating is largely mental.

To find a number from a logarithm,

the operations are reversed.

From rule 1 we see that to multiply two numbers we have to add together the numbers.

Example I —67.4 x 43.21 = ?

log. 67.4	1.828660
log. 43.21	1.635584
	3.464244

3.464340 = log. 2913
3.464191 log. 2912
149 diff. (Note diff. in margin at right. Kent P. 139)

3.464244
3.464191
53

53 153 = 35 (nearly.) Do not carry these proportions out too closely.

2912+.35=2912.35 and 67.4 x 43.21=2912.35. Ans.

Ex. 2. 74.62÷41.7= ?
log. 74.62 1.872855
log. 41. 7 1.620136
.252719=log. 1.789 +
∴ 74.62 ÷ 41.7=1.789+ Ans.

Ex. 3. 46.52^3 = ?
log. 46.52 = 1.667640
3
4.992920=log.98383.+Ans.

Ex. 4. $\sqrt[3]{6734.2}$ = ?
log 6734.2 = 3.828286
divide by 3 = 1.276095 = log
18.884 + Ans.

Ex. 5. Solve $d = .239 \left(\frac{76.2}{\left(\frac{41.32}{5641} \right)^{\frac{1}{2}}} \right) .386$

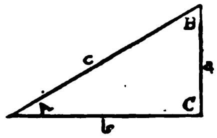
log. 41.32 = 1.616160
log. 5641 = 3.751356
3.864804
.5(=½)
.4324020
— 1.5
2.9324020

Notice in this last operation the use of a negative characteristic with a positive mantissa. The multiplication is done separately. The term — 1.5 is entirely different from 1.5, in the latter case only the characteristic is negative. The term — 1.5 = — 2+ 5, and in the work above is so treated. Instead of using the decimal .5 to find the square root above, it would have been possible to divide by 2 as follows:

2 | 3.864804 =
2 | — 3+1.864804
$\bar{2}$.932402 (substrahend)
log. 76.2 = 1.881955 (minuend)
2.849553
.387
multiplication omitted
1.102677
log. 239 = $\bar{1}$.378398
.481075 = log. 3.02745
Ans.

The method by logs. is the only method practical for a complicated equation like the above.

Ex. 6. Solve the following triangle.

47.653=c  a=21.34

Sin A= a/c
log. 21.34 = 1.32919
log. 47.653= 1.67809
log. Sin A= $\bar{1}$.75110=9.65110 -10
∴ A = 26°—36′—14″
Cos A=b/c
log. 47.653 = 1.67809
log. cos. 26°—36′—14″=9.95140—10
log. b =1.62949
∴ b =42.608.

In this last example the log. sin., log. cos., etc., are from a table of log. functions not found in Kent's Pocket Book. Such tables are in civil engineers' field books, works on trigonometry, etc.

The hyperbolic system requires a somewhat different treatment when in use. The table of hyperbolic logarithms, or log. e as I shall hereafter call them, in Kent's Pocket Book is a very full one, due possibly to the fact that Mr. Kent is notably a steam en-

gineer.

The general principles of logs. apply here, but in this case the characteristic and the mantissa are inseparable.

The base of this system or value of e is 2.718281 instead of 10, as in the common logs.: log. 2.718281 = 1.00.

Log. e are not used in such calculations as multiplication, as they are not so readily handled as common logs. A table of log. e from 1 to 100,000 would be about the size of a Webster Dictionary. These logs. will be used by a designer mostly in formulas when a direct substitution is all that is necessary. Take for instance the mean effective pressure of steam in a cylinder where steam is cut off at 1-5 stroke, assuming 17 pounds back pressure and steam at 100 pounds gage:

$$\text{Formula } P = p \times \frac{1 + \log_e . \ R.}{R} - B.$$

P. = M. E. P.

p. = Gage pressure.

R. = Ratio of expansion.

B. = Back pressure.

$$P = 100 \times \frac{1 + 1.6094}{5} - 17.$$

The reader can solve for himself. Should the table not contain the log. e required, it may be found by multiplying the corresponding common log. by 2.302585.

The child of the logarithm is the slide rule which is as much of a time saver over its parent as the log. is over the long method.

If the reader will take a piece of bristol board (or drawing paper) 11" x 2" long, ruled as in Fig. 1, he can, with a very little labor, make a paper slide rule that will give very satisfactory results.

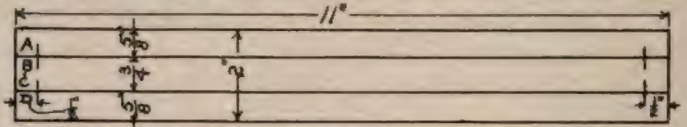


FIG. 1.

Scales A and B are to be exactly alike and scales C and D will also be alike. Take the table of logs. in Kent, and starting at the left measure with an engineer's scale, 3."01, mark the point 2 (see Fig. 2) and draw the cross line —. It will be noticed from the table that the log. of 2 is .301 +, so that we have multiplied the mantissa of log. 2 by 10, in order to make our scale of reasonable size. In the same manner measure off a distance found by multiplying log. 3 by 10 (4."77) and mark it 3.

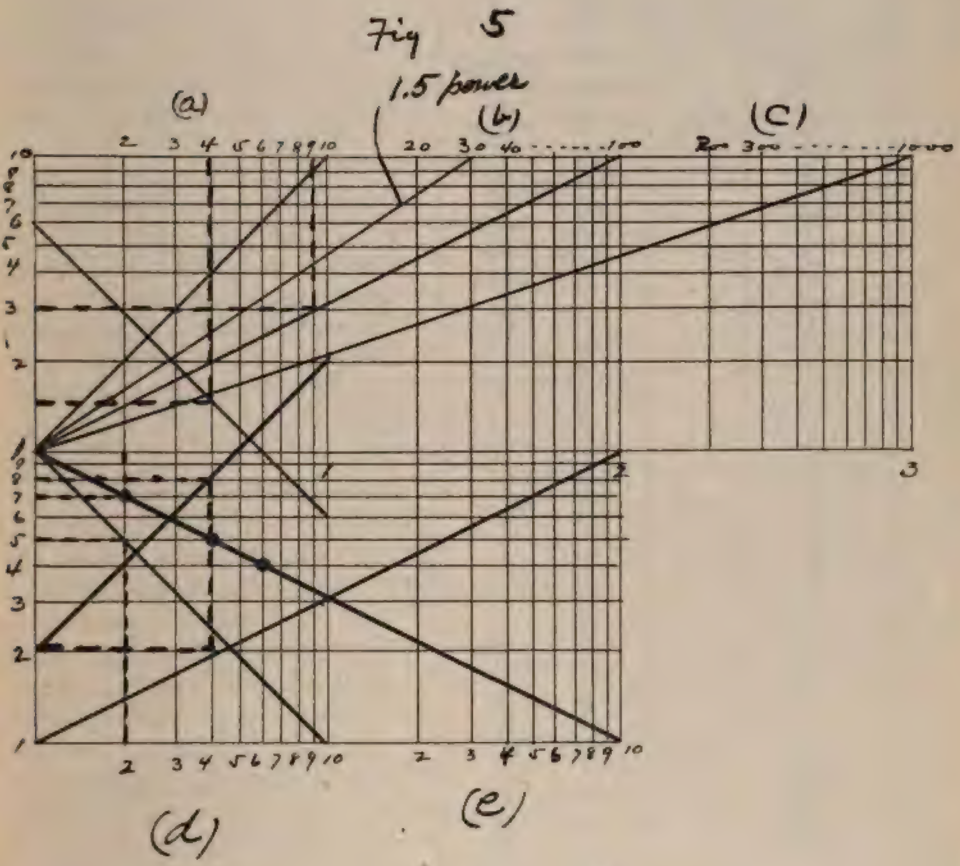
To find point 4 take twice the distance 1 — 2 point :5, measure back from points 10 the distance 1 — 2; for point 6 add distance 1 — 2 to distance 1 — 3; point 8, add distances 1 — 4 and 1 — 2; point 9 is twice distance 1 — 3 —, etc., etc.

The reason of this is apparent from the rules for use of logs., viz., adding logs. instead of multiplying numbers together, and subtraction of logs. instead of dividing numbers.

The distances 1.1 — 1.2 — 1.3 — are found from the mantissa of logs. 11 — 12 — 13 —, multiplying by 10 in each case, and will be 0."41 — 0."79 — 1.11, etc.

Scales A and B are the same as C and D except that they are one-half the size.

Fig. 2 shows the rule complete. Paste the outside edges to a piece of cardboard, and when dry, cut carefully along the long lines, cutting the



centre completely out. We now have the slide rule complete.

To multiply, we have only to add distances on the rule. For instance, to multiply $35 \times 45 = 1575$. The rule gives results to 3 places, and the last one (5) is known by multiplying the last figures together mentally.

The method of procedure is as follows: Push the slide to the right until 1 of scale B comes opposite 3.5 of scale A (see Fig. 3). Opposite 45 of scale B can be read the result on scale A. Had the dimensions on the scale been smaller, the work of interpolating would have been easier. Right here let me say that the interpolating is the hardest part of slide rule work. After one has acquired the knack of quickly and accurately dividing the small divisions on the scale, he can perform the ordinary operations with a rapidity that is little short of supernatural. By this, I do not mean "slide rule

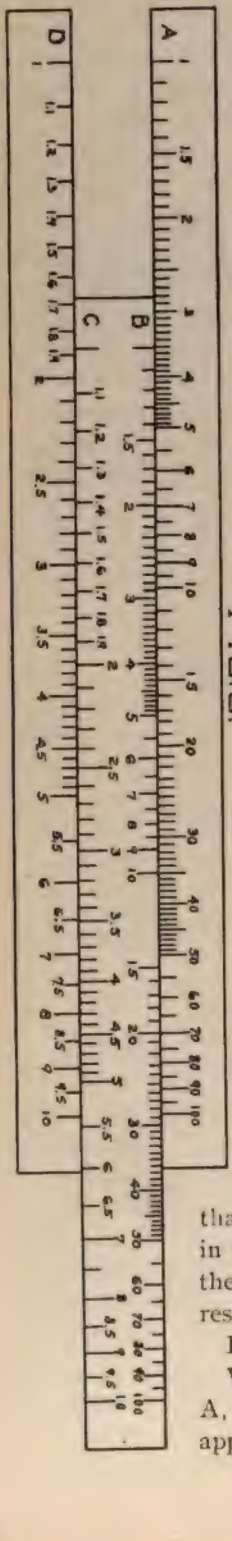


FIG. 3.

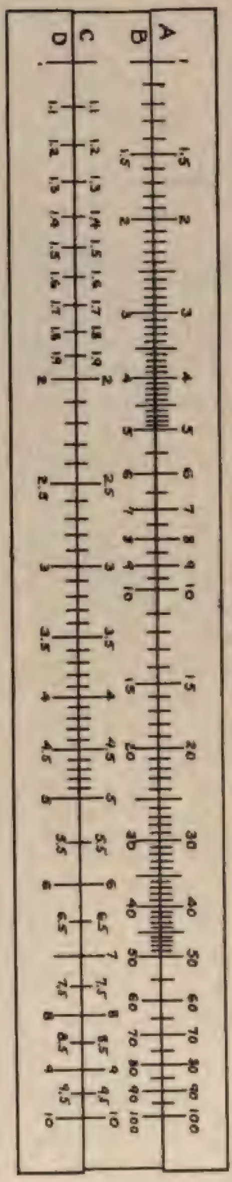


FIG. 2.

gymnastics," but the plain multiplication and divison of everyday work.

As scale A is half the size of scale D, a distance 1—5 say, on scale A, equals the corresponding distanee $\frac{1-5}{2}$ on scale D. Now as these distances equal logs., this is equivalent to squaring and extracting the square root of numbers. Ex ∴ To $\sqrt{3.5}$—Fig.3 place 1 on scale B opposite 3.5, the root is found on scale D opposite 1 of scale C, and is 1.87.

Ex. $\sqrt{31.5} = ?$

Opposite 31.5, scale A, is 5.6, scale D.

From 1 to 10, scales A and B, is one complete scale, and as we know, is exactly like the portion 10 to 100, on scale A and B. Let us call 1—10 section a, and from 10 to 100 section b. In keeping track of the decimal point when multiplying, we use this sectional division. If the result is found in the same section as the multiplicand, the answer will contain one digit less than the sum of the digits in the multiplicand and the multiplier. Ex. $2 \times 4 = 8$

2 has 1 digit.
4 has 1 digit.

2 digits

Multiplicand and answer are found in the same section; therefore the answer has one less digit than the sum and is therefore 8 and not .8, 80, etc. Of course, in this case we know the result has 1 digit, but in larges factors the result isnot so easily known. If the factors are 2×6, the result 12 will be in the next section and will have 2 digits.

In division the converse of the above will be true.

When squaring, if the square appears in the first section, scale A, it will contain twice the number of digits minus one that appear in the root. If the square appear in the second

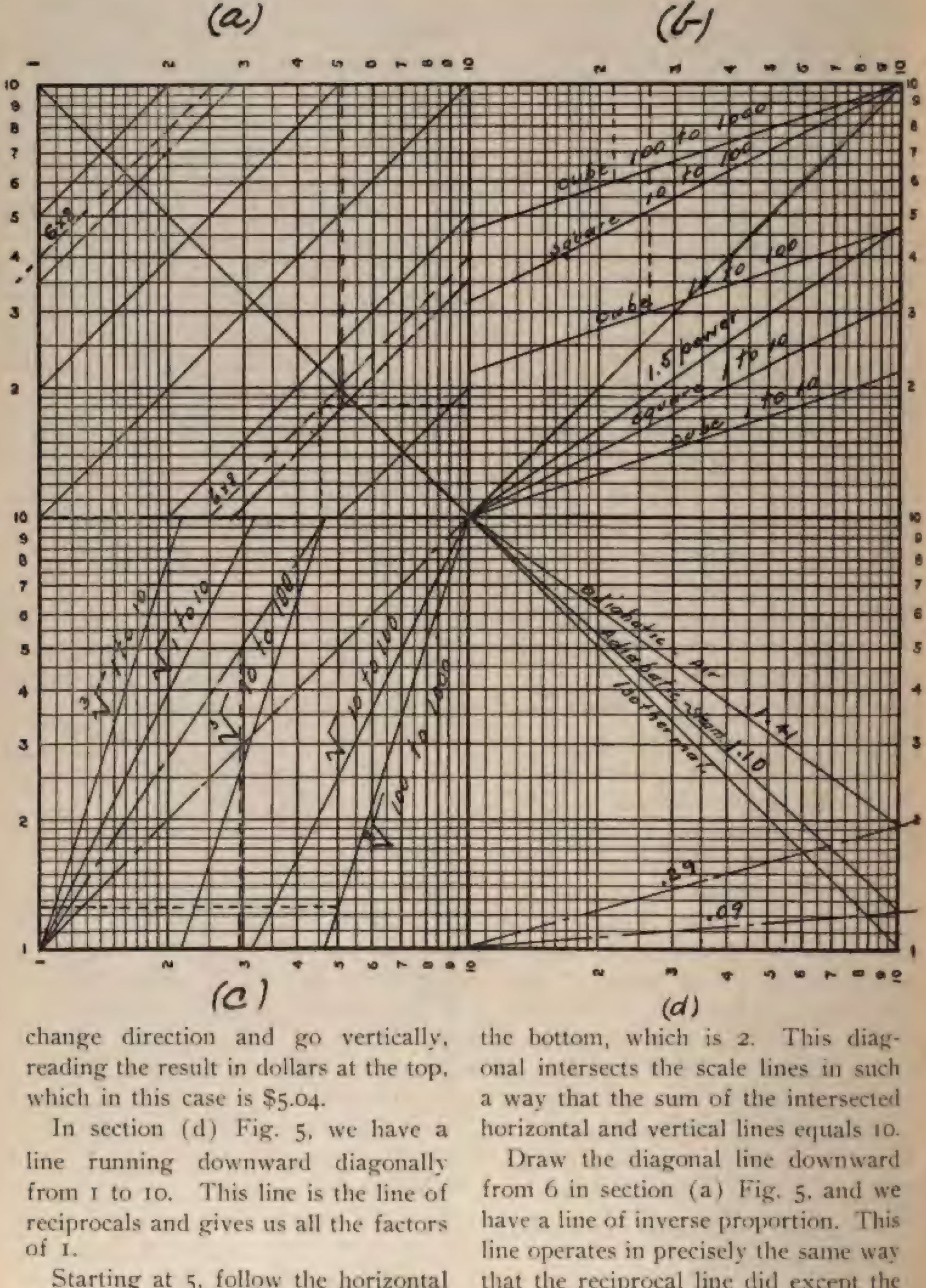
section, it will contain twice the number of digits that appear in the root, while the converse is of course true for square root.

For other operations on the slide rule, the reader is referred to works upon that subject. Cubes and cube roots are not very satisfactory problems on the slide rule. The best way to solve problems of involution and evolution other than squares and square roots is by the use of logs.

For solving certain equations and problems it is quite often possible to use a cross section paper ruled to correspond to a series of logarithms. Fig. 4 is a sheet of such paper as may be procured of dealers in draftsman's supplies. The distances 1 — 2, 1 — 10, etc., correspond to the mantissa of common log. in precisely the same way that spaces on the slide rule did, and may be to any convenient scale. Fig. 5 is the same thing with different lines and to a smaller scale.

In square (a) Fig. 5, the diagonal line 1 — 10 is the line of unity and will intercept equal values on the horizontal and vertical lines, for as the line 1 — 10 is at 45 degrees, it is apparent that the vertical distance is the same as the horizontal distance, and a horizontal line would intercept a vertical line of the same value. If, however, we draw the 45-degree line extending diagonally upward from 2, we shall have added the vertical distance to each horizontal distance on the paper. Therefore, to multiply any number by 2, we have only to follow up from the bottom along the line representing the value we wish to multiply by 2, and the intersection of the vertical line with the diagonal from 2 will be on the horizontal line representing the value of the result. Suppose we follow the vertical line 4 upward from the bottom section (d): The line crosses the horizontal line 2. Pausing here a minute we may conceive a rectangle bounded by the dotted lines in this section, and as we know that the diagonal line is at 45 degrees, this figure must be a square. We have the value of the horizontal side of the square as 4, therefore the vertical side is four, and as we have already come a distance of 2 the diagonal line marks the sum of the logs. of 2 and 4, which equals log. 8 as shown by following the horizontal line toward the left. Portions of two sections are required to complete the number of multiplications by two, but by referring to section (a) Fig. 4, it will be seen that a portion of the diagonal line from 2 runs diagonally to the right, and the remainder runs from the opposite end of the 2 line, diagonally to the left. By this means all the calculations may be made in a single square.

Let us apply this to a formula having but one variable. A piece of 6 x 8 timber, one foot long, contains 4 board feet. Draw from 4 in (a) Fig. 4, the dotted diagonal extending upward, completing the line by drawing the dotted diagonal from the right hand end of the line 4 but extending downward. If we have a stick of timber 45 feet long, from 45 follow the dotted line upward to the diagonal intersection, then along the horizontal to the right, and the answer will be 180 board feet. If the piece is $28.00 per *M*, draw the dot and dash line diagonally upward from 28 on the bottom scale, and at the intersection of this diagonal with the line of resultant board feet,



change direction and go vertically, reading the result in dollars at the top, which in this case is $5.04.

In section (d) Fig. 5, we have a line running downward diagonally from 1 to 10. This line is the line of reciprocals and gives us all the factors of 1.

Starting at 5, follow the horizontal line to the right, intersecting this diagonal, then downward along the vertical line and read the reciprocal of 5 on the bottom, which is 2. This diagonal intersects the scale lines in such a way that the sum of the intersected horizontal and vertical lines equals 10.

Draw the diagonal line downward from 6 in section (a) Fig. 5, and we have a line of inverse proportion. This line operates in precisely the same way that the reciprocal line did except the factors will be the factors of the number from which the line started instead of being factors of one. These

lines may be used to solve all problems of inverse proportion, and will be especially adapted to finding the speed of pulleys and gears. Taking the diagonal line from 6 as an example; a pulley 20" dia. runs 300 R. P. M. This 20" pulley belts to a countershaft which is to run 1,500 R. P. M.; required the size of the pulley on the counter. From 15 follow the dotted line toward the right to its intersection with the diagonal, then up, reading the result in inches, in this case 4".

To square a number we multiply the log. of the number by 2, the result being the log. of the number squared. Draw a line from 1, section (a) Fig. 5, to 100, section (b). We have formed a triangle, the base of which is twice the altitude, so that by similar triangles we know that any vertical will intersect the slant line at a distance from the left or apex vertical, equal to twice the length of the given vertical. Start at 3 and follow the horizontal to the right and at the intersection with the slant line, change direction and read the result 9, at the top.

The slant line 1, section (a) to 1,000, section (c), will, in exactly the same way, be the line of cubes. At section (b) Fig. 4, is shown the usual way of lining a section for squares and cubes, and (c) Fig. 4, is the lining for square roots and cube roots. In Fig. 5 it will be noticed that the 1.5 power is drawn to a point midway between the unity line and the line of squares.

At Fig. 5 (d) and (e), we have again the line of squares. From 1, section (d), draw a slant line intersecting the square line on the vertical 10, terminating of course at 10, section (e). This line will represent a value by the equation $x\sqrt{y} = 10$.

The dots represent several solutions involving two variables and are successively $7\sqrt{2.04} \ldots 5\sqrt{4} \ldots 4\sqrt{6.25}$.

In section (d) Fig. 5, we have the lines of isothermal and adiabatic expansion under certain conditions. The co-efficient .29 represents the exponent for the ratio of expansion of air by heat and is from the exponent 1.41 of the adiabatic equation, thus, $\frac{K-1}{K}$, and to draw this line a distance is measured upward from 1 on the line 1 — 10 at the right equal to .29, the distance 1 — 10. In the same way we find the exponent .09 from 1.10, the right end of the line being .09, the distance 1 — 10 measured from 1.

By means of these lines, adiabatic expansion curves may be drawn, using any exponent for the adiabatic equation such solutions involving a minimum labor and practically no figures.

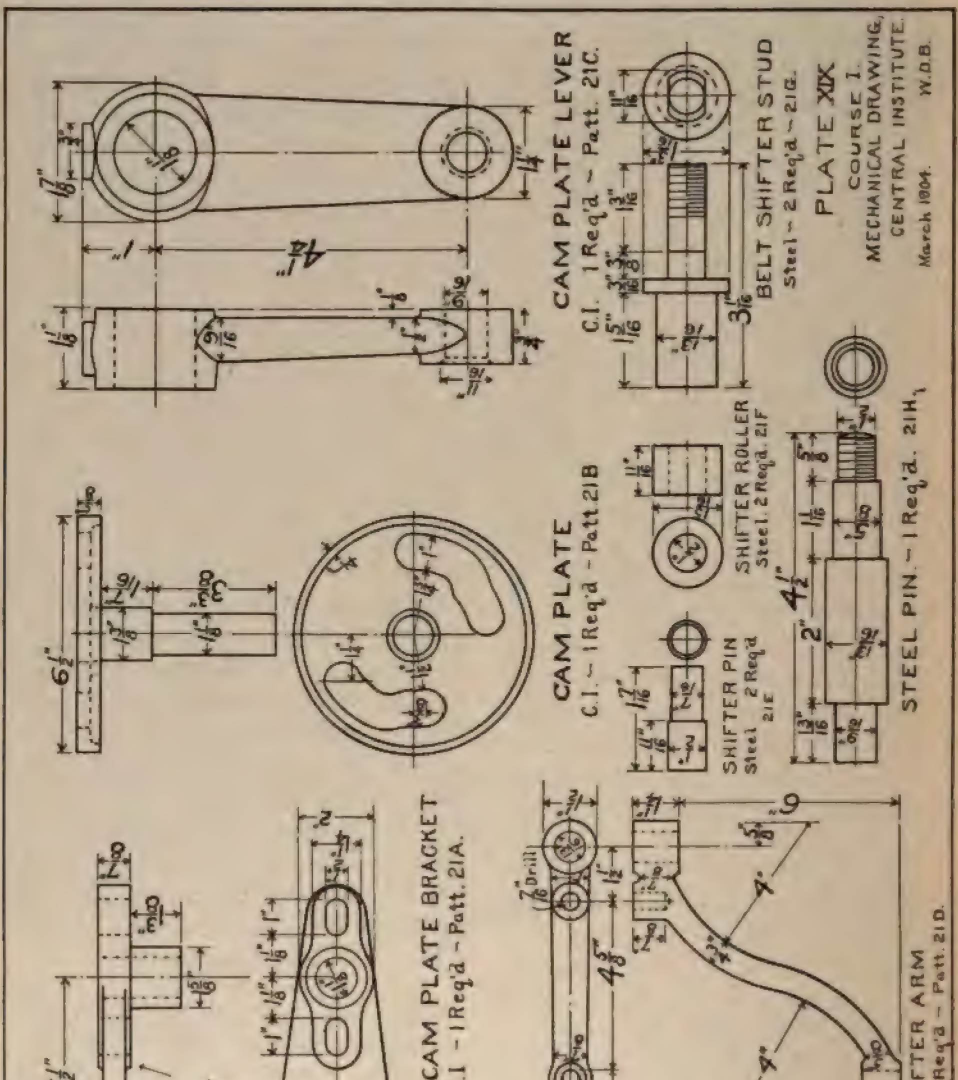
If the reader has mastered the principles of logs., he will have no difficulty in grasping and using these practical applications. There are other uses for logs. and labor saving devices connected with them which the reader is left to discover for himself.

The automobile principle has been applied in Paris to baby carriages. The nurse sits behind and regulates the speed, which does not exceed a moderate figure.

The greatest clock in the world, the dial of which will be 120 feet in diameter, is being built at Milwaukee for use at the Louisiana Purchase Exposition this year.

Elementary Mechanical Drawing.

(Continued from June Issue.)



(Continued under head of "Current Topics")

CURRENT TOPICS.

With next issue of The Draftsman, the Elementary Course in Mechanical Drawing is completed.

The whole series of articles are to be revised and published in two parts or divisions. The course has been used quite successfully at The Central Institute, Cleveland, O., and is the first course in their catalog.

Part III. and Course II. of the Mechanical Courses of this school will receive attention next.

Part I., Architectural Course, at this school is the same as the Part I. Mechanieal, and Part II, Architectural, will begin in our
" Home Study Department " in the August issue.

If there are any of our readers who would like to use this course in day or night schools, we would be pleased to hear from them.

(Continued from "Home Stuty,,

The student is now requested to copy the matter as shown on Plate XIX and finish it up complete with dimensions, inscriptions and title, with the border and margin as on the regular sheets.

Use a neat and uniform size of lettering and figures, putting them in in pencil and submit to the instructor for approval before inking. Keep the title well together and not let it appear as if it were a part of the inscription just above. Exercise care in arranging objects so not to leave too much space at the side or bottom.

Do not remove from the board until you have made Plate XX which is to be a tracing of Plate XIX. Look over the instructions on " Tracings " on a previous page.

Plates XXI and XXII.

"Indispensable" Combination Drawing Set.

BY KOLESCH & CO.

A cheap, portable, yet strong and accurate pair of pocket compasses has long been the wish of all whose occupation involves the use of drawing instruments, builders, draftsmen, mechanics, engineers, surveyors, architects, students, etc. Heretofore all pocket compasses were either too cheap to be moderately accurate, and durable, or so high in price as to forbid their coming into general use.

Messrs. Kolesch & Co., New York, have at last succeeded in constructing an instrument, which overcomes these drawbacks, while it embodies strength, accuracy and durability.

The " Indispensable " Combination Drawing Set, as shown in illustration, consists of a pair of divider's pencil compasses and pen compasses in one piece. As can be seen in the cut, the pen and pencil point are each made integral with one of the steel points and each one of these pieces is firmly riveted to one of the legs; it is reversible, so that either the steel point or the pen and pencil point can be brought down on the drawing surface. By this method there are no loose parts or screws, which might get lost, while the instrument is readily adjusted for use. The instrument is made of strong steel-metal, bent and braced, to make it as light and rigid as possible. The joints are very

strong and of an improved style, so that they will never lose their adjustment. When closed the instrument measures only 6¼" x 5-16" x 7-16" and weighs only ¾ oz. The instrument is nicely finished and nickel-plated.

The "Indispensable" Combination Drawing Set is also furnished in a

neat, strong pocket case with clasp, which also holds a good 5" ruling pen. The dimensions of the case are 5" x 1" x ⅜" and the weight is only about one ounce. On account of its lightness and compactness this set can be conveniently carried in the vest pocket and is intended "Indispensable" especially for out-of-door work.

The "Indispensable" Combination Drawing Set, sent postpaid, for 75c.

The "Indispensable" Combination Drawing Set with 5" ruling pen in vest pocket case, sent postpaid, for $1.25, by

KOLESCH & Co.
138 Fulton St., New York.

Thirty-seven per cent of the American people now live in cities of more than 4,000 inhabitants.

Dear Sir — In your December issue I noticed an article under the heading "Something for Our Geometrical Friends." At the time I thought the printer had made a mistake or that the writer thought the intelligence of your readers was considerably below par. At any rate, I thought everybody who was interested would see the error and that it was not worth while to take up your space in answering it, but seeing in this month's issue that Florence W. has taken the matter up, and was airing her mathematics by making a mountain out of a mole-hill, I would like to show you how she could have saved your valuable space and also the patience of your readers.

Mr. Babbitt sets forth in the first line of his proof that "*The* line H E (the perpendicular bisector of BD)," etc. Now the line H E is not the perpendicular bisector of BD which any one can prove without taking your space, and having taken for granted that which is wrong, his whole proof is wrong, so why bother with an absurdity.

I might add again that some people jump at conclusions without much thought. Florence W. starts out by saying, "The error is found in the assumption that KE equals CE. Now I claim that KE does equal CE, seeing that HE was made a perpendicular bisector to KC. Therefore KEC is an isosceles triangle. Yours truly,

H. W. GOCHER.
Seattle, Wash.

In Sweden bricks are laid in zero weather by heating the sand for the mortar.

Sweden sent three-quarters of four million gross boxes of matches imported into this country last year.

Cox Computers.

Civil, mechanical, electrical, hydraulic and other engineers have in their professional work many problems, more of less complicated, to solve over and over again by means of the same or similar formulas. The routine work thus caused often becomes so wearisome that any method or device which facilitates this tiresome labor is gladly welcomed. The oldest device, and one which cannot be too highly valued as a labor saver, is the slide rule, but its use in the case of complicated formulas is somewhat tedious and uncertain, unless the manipulator has had considerable practice with it and is quite sure of his ground. Others find the graphical method by means of diagrams a great help, whilst many others plod along and solve their problems as best they can by the old-fashioned arithmetical or (perhaps in some cases) logarithmical method.

A new device for solving some of the most tedious engineering problems has come into more or less general use during the last 12 or 14 years, namely, Cox Computers. Each computer is designed to solve by simple mechanical means one well-known formula, such as those relating to the strength of shafting, belting, gears, beams, or the flow of air, gas, water, etc., in pipes, and many others of similar complex nature. Cox Computers consist in their simplest form of a foundation plate in the center of which a disk revolves. Upon these logarithmic scales corresponding to the several factors of the formula, are arranged and combined in such manner that by turning the disk round and bringing the values of two of the known factors of the formula upon contiguous scales opposite each other, the value of the unknown fourth factor is at once seen opposite the known third one. When there are 5 or 6 factors in the formula, an extra piece of sectoral shape with similar scales upon it, revolves between the disk and the plate about the common center.

One very important feature which adds considerably to the value of these computers, and which has been so thoroughly appreciated, is that in problems of which many solutions are possible, all the different values of the correlated factors which would produce the *same result* are at once read off, so that all that remains to be done is to select the most suitable value for each factor. Thus, in the case of the computers for the strength of gears and rectangular beams, the pitch and face of the former and the breadth and depth of the latter are correlated. When solving such problems arithmetically, the value of one of these terms must be assumed and the other one calculated from it, only to find perhaps that the combination of values thus obtained is quite unsuitable, and the work must consequently be all done over again. With Cox Computers, however, a suitable combination of values of such correlated terms can be at once selected from the whole range of possible values, all of which produce the same result. In this way, not only are hours of tedious calculation avoided, errors eliminated, but the solution of the problem is obtained with a far greater appreciation of the ef-

fects produced by a slight modification of any one of the factors of the formula than is possible by working out arithmetically any number of suppositional cases by means of the formula.

In the case of formulas containing a variable co-efficient, no attempt is made to decide upon a fixed value of the same, but a special scale is provided covering all probable values from which the user may select the one which accords with his judgment, precisely as he would do if he were solving the formula in the usual manner.

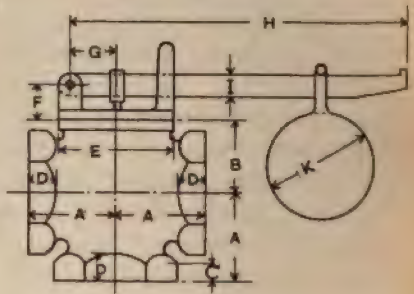
These computers are made of the best bristol board, and the sizes vary from 4½ by 6 to 12 by 14 inches. The smaller ones are generally put up in cloth or leather cases, while the larger ones, which are more suitable for drafting room or office use, are mounted on substantial cloth covered binder's board.

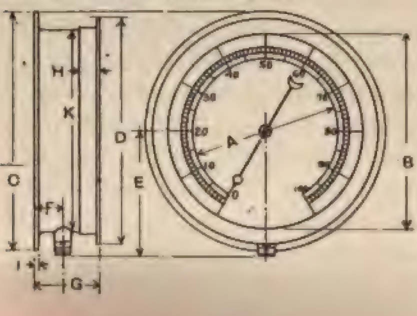
Thousands of Cox Computers have been sold, and they are used by engineers in every English-speaking and many foreign countries, from Norway to South America, and from Canada to New Zealand. The most flattering opinions have been given unsolicited as to their "convenience, accuracy, unquestioned value, simplicity," etc., by engineers of the highest standing in their respective professions, who use them regularly. To such their cost is saved in one day by reason of the increased amount of work they have been able to get through, whilst as a means of checking calculations made in the usual manner, they are invaluable.

A New Book for Draftsmen.

For the draftsmen who have to lay out drawings in which any pipe work may exist the book, "*Pipe, Fittings and Valves*" will be indispensable. There are over 50 tables of articles used in pipe work and the dimensions and illustrations are very complete.

Every draftsman, architect and engineer should have one in a handy place so when called upon to lay out such work he may do it rapidly. Bound in flexible cloth, postpaid, 50c. The Draftsman, Cleveland, O.





A few illustrations out of "Pipe, Fittings and Valves.

A Convenient Drawing Board and Curves.

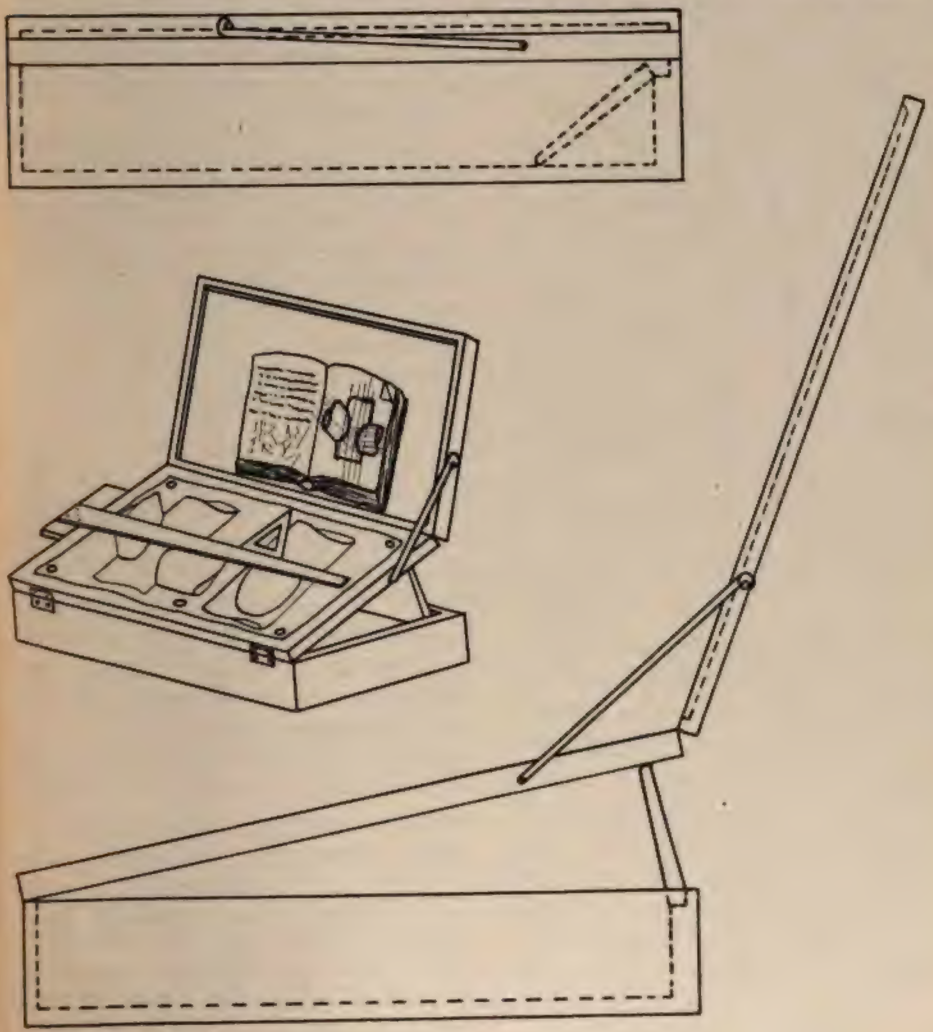
R. W. DICKENSON.

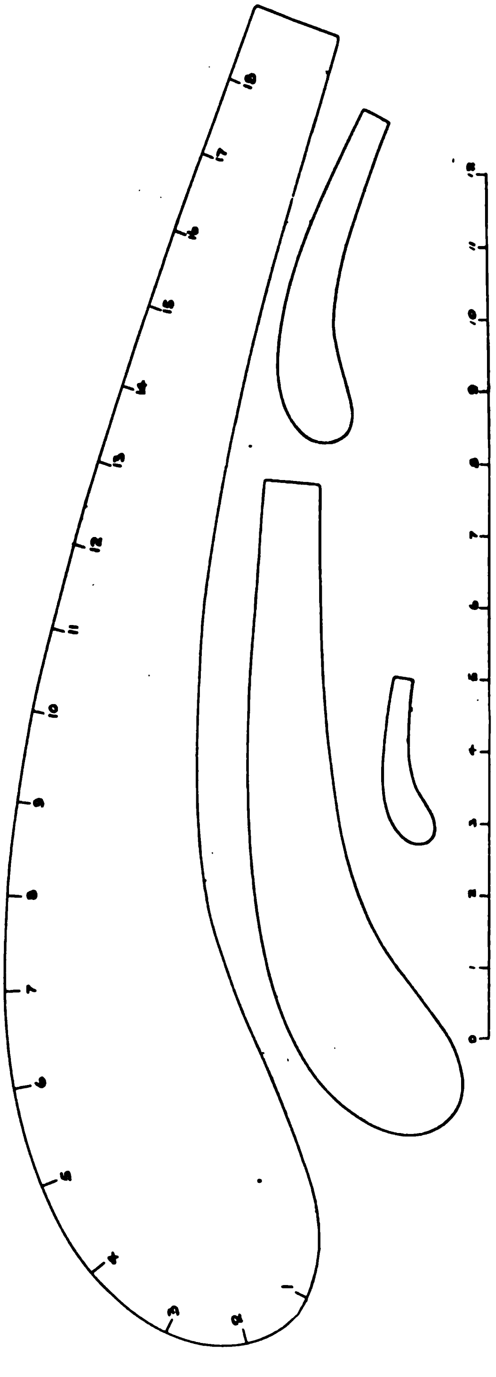
I have not had time to go into the board design yet, but you will find enclosed two sketches which you may find useful in the meantime.

The set of four curves have proven themselves extremely useful for a number of years, doing away entirely with French curves. Being made in full, half, quarter and eighth sizes, makes them more useful, and being a generated curve, it is only a matter of a few minutes to make one any size out of cardboard or thick drawing paper.

They are made of clear celluloid and are all figured the same as the large one shown. If anyone desires to know the method of setting the curve out, I will send on same later.

The other sketch, I think, explains





itself. The bottom base serves to hold spare paper, finished drawings, instruments, paints, etc., the drawing board forming a lid for same. The lid for the board serves also to hold books and drawings when open as shown.

As a set for home use, I think it cannot be beat.

Book Notes.

A neat little volume, compiled with the view of placing before yachtsmen and the reading public who are fond of blue water, some interesting and useful information.

The author has to his credit several other good books of a nautical nature.

The above book has much of value for even the landsman, and if one contemplated a voyage it would be a valuable adjunct to his library. It is well bound, pages 3½ x 5¾, price 25c. Published by Gardner & Cox, No. 1 Broadway, New York.

Three of the illustrated "*Carpenter and Builder*" series of technical manuals have been received. This series consists of several neat books, entitled Bricklaying, Slating and Tiling, Joining, Decorating, Plumbing, Masonry, Concrete, Artificial Stone, Terra Cotta, etc., Home Handicrafts, Painting and Varnishing, Plastering.

These useful and instructive books are especially prepared for self-instruction, printed on good paper and illustrated wherever the subject needs it. Price 25c. Descriptive circulars free. Address The Industrial Publication Co., 16 Thomas St., New York City. Send for specimen pages of their monthly journal, "Self-Education."

Dotting Pen.

Ernest G. Ruehle, of New York, N. Y., has invented a new and improved dotting-pen.

The purpose of this invention is to provide a simple, durable and economic dotting-pen, thoroughly effective in use and which may be conveniently and expeditiously cleaned, and so constructed that reserve dotting-wheels of various sizes may be carried in the body of the pen, and so that the dotting-wheel at the point of the pen can be readily removed to be cleaned, sharpened and replaced.

A further purpose of the invention is to provide a feeding device for the ink, located within the body and comprising two opposing members oppositely bowed or curved secured at one end of the inner faces of the members of the body of the pen, the outer ends of the members of the feed device being free and pointed and made to more or less closely approach the periphery of the dotting-wheel and to provide each member of the feed device with means of adjustment independent of the adjustment of the body of the pen, whereby the feed device may be supplied with ink in the same manner and as conveniently as the ordinary drawing-pen, insuring a regulated, uniform, and reliable supply of ink to the dotting-wheel under all conditions of use.

The invention consists in the novel construction and combination of the several parts, as will be hereinafter fully set forth, and pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a front elevation of the improved pen. Fig. 2 is a side elevation of the same; and Fig. 3 is a sectional front elevation of a compass-pen, illustrating in dotted lines the pivoted member of the limb in open position.

A represents the body of the pen, and B the handle which is to be employed when the pen is to be used as a regular drawing-pen; but in Fig. 3 I have illustrated the body of the pen as pivotally attached to a block B′, having a polygonal stem B^2, adapted to enter a socket in a limb of a compass. The body A consists of two oppositely bowed or curved members *a* and *a*′, both of which are connected with a head member a^2, the member *a*′ being pivotally connected to the said head member, and in the ordinary form of the pen the handle B is attached to the head member a^2, and when the pen is to be used in connection with a compass the aforesaid block B′ is pivotally attached to the said head.

The lower terminal portions 11 and 12 of the body members *a* and *a*′ are straight, as is shown in Figs. 1 and 3, and a pin 13 is secured to the fixed member *a* of the body, being adapted to pass freely through an aperture 14 in the pivoted or swing member *a*′ when the two members are brought together in working position.

A dotting disk or wheel is adapted to turn freely on the pin 13, and between the terminal portions 11 and 12 of the aforesaid body members *a* and

a'. These body members are adjusted to and from each other and are held in adjusted position by means of an adjusting or set screw 16, which is preferably loosely passed through the swing or pivoted member *a'*, the threaded portion of the screw entering a threaded aperture in the fixed or stationary member *a*, as is best shown in Fig. 3.

At the upper portion of the body A a second pin 17 is secured to the fixed member *a*; but this pin 17 stops short of the swing or pivoted member *a'* when the latter is closed, as is shown in Figs. 1 and 3. This auxiliary or second pin 17 is adapted to carry supplemental dotting disks or wheels 18, the said dotting disks or wheels being provided with peripheral teeth of different sizes, so as to produce different lengths of dots on the paper or surface over which the disks or wheels are to travel.

The device for feeding ink to the

Fig. 1.

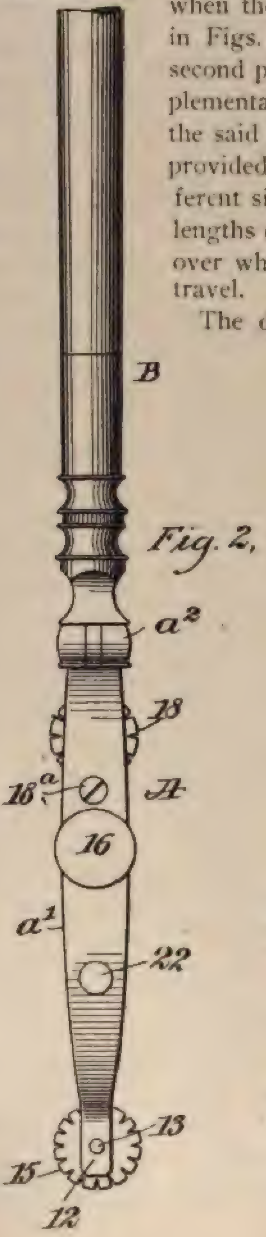


Fig. 2.

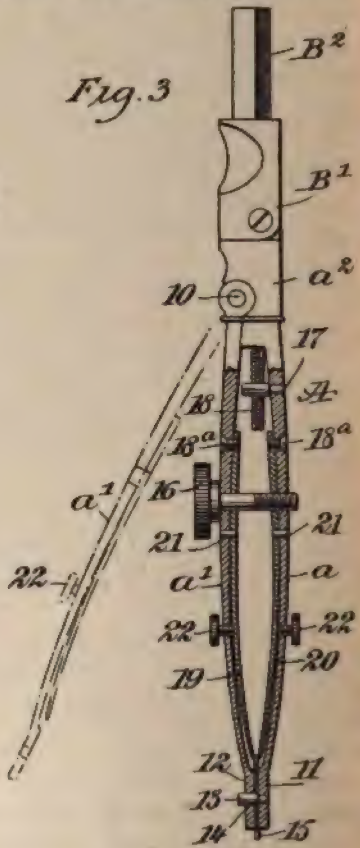


Fig. 3

dotting disk or wheel in action comprises two members 19 and 20, preferably made of spring steel and oppositely bowed or curved, following practically the lines of the inner faces of the body members *a* and *a'*. The upper ends of the members 19 and 20 of the ink-feeding device are secured to the members *a* and *a* of the body by suitable screws 18*a*, located above the adjusting-screw 16 for the body, and below the said adjusting-screw 16 guide-pins 21 are secured to the body members *a* and *a'*, passing through suitable openings in the members 19 and 20 of the ink-feeding device. The said members of the ink-feeding device are also provided with suitable apertures through which the stem of the adjusting-screw 16 of the body may freely pass. The lower ends or extremities of the members of the ink-feeding device are made to converge more or less and are adapted to normally have a position one at each side of the toothed peripheral surface of the dotting disk or wheel in action, as is shown in Figs. 1 and 3.

The ink is fed to the ink-feeding device by means of an ordinary pen or a feeder usually contained in bottles of liquid ink in the same manner as the point of an ordinary drawing-pen is fed, and the volume of ink thus placed between the members of the feed device, as is shown in Fig. 1, is constantly in engagement with the periphery of the dotting wheel or disk, so that the said dotting wheel or disk, as the pen is operated, will not make a miss.

The amount of ink to be fed to the dotting wheel or disk in action is regulated through the medium of regulating or adjusting screws 22, one of which is provided for each member or jaw 19 and 20 of the ink-feeding device. These adjusting or regulating screws 22 are passed through threaded apertures in the body members *a* and *a'* of the pen and have engagement at their inner ends with the outer faces of the members or jaws 19 and 20 of the ink-feeding device. Thus it will be observed that the adjustment of the pen in its entirety is completely under the control of the operator and that the pivoted or swing member *a'* of the body may be carried away from the fixed member *a* whenever it is desired to clean the pen or to change the dotting disk or wheel.

This pen is perfectly adapted for the purpose intended. It is readily cleaned, and the supply of ink to the dotting disk or wheel will be constant, and ink can be supplied to the feeding device as readily as ink can be supplied to the working points of an ordinary drawing-pen.

CHANGES.

The Cleveland Engineering Agency has opened an office at 1065 The Rose Bldg., Cleveland, O., where applications will be received.

Mr. G. W. Spellman, formerly of this city and for some time with the Engineering Department of Zion City, Ill., has been unanimously appointed by the council to the office of City Engineer of that growing center of industry.

A copy of Tables and Other Data for engineers and business men, compiled by Charles E. Ferris, B. S., of the University of Tennessee, has come to hand.

It is the fourth edition of this neat little book and is full of good things. Leather bound, 24 pages, gilt edges, price 50c. Published by the University of Tennessee, Knoxville, Tenn.

Beam Compass.

Nathaniel B. Stone, residing at Outlook, Washington, has invented a useful improvement in beam-compasses.

The object of this invention is to provide a beam-compass the back edge and sides whereof shall be left free and unincumbered, thereby permitting the use of said back edge for a straight-edge and leaving the scale on the sides uncovered from end to end of the beam at all times, all as will be hereinafter more fully described and claimed.

Referring to the accompanying drawings, which are made a part hereof, and on which similar reference characters indicate similar parts, Figure 1 is a side elevation of a beam-compass embodying said invention; Fig. 2, an under side plan of the same; Fig. 3, a cross-section on the dotted line 3 3 in Fig. 1; Fig. 4, a similar section on the dotted line 4 4; Fig. 5, a view looking downwardly from dotted lines 5 5 in Figs. 3 and 4, the beam being indicated by dotted lines; and Fig. 6, a view of a modified form.

In said drawings the portion marked A represents the beam, B one of the points, and C a socket for containing the other point.

The beam A is of a rectangular form, preferably hollow, and is formed with a central groove or slot in its front face. Its back edge is straight to adapt it for use as a straight-edge, and a graduated scale is formed on one or both of its side faces by which the position of the points may be accurately and easily determined.

The point B is formed with a head *b* on its base and with a groove on each side near said head to form a neck which will slide readily in a slot or groove *a* in the front face of the beam. Near its base said point is formed screw-threaded and has a nut *b'* on said screw-threaded portion. A flanged plate B' is mounted to slide on the face of said beam and contains a central aperture of a size to receive the base end of point B. Indicating-points 1 are formed in the center of the flanges of said plate, said points being exactly in line with the center of point B. Said plate B' is mounted on the end of point B, the head *b* extending through said plate. Said head is then slid into the slot *a* of the beam and adjusted to the position desired on said beam. The plate is then securely locked in said position by tightening the nut *b'*, which draws the head against the inner face of the beam, as will be readily understood. When it is desired to move said point, the nut *b'* is loosened and the point slid to the desired position, and then said nut is again tightened, thus securing said point in any position very quickly and easily, as will be readily seen.

The socket C is formed at its base similar to the construction of the base of point B and has a head *c*, a nut *c'*, and a flanged plate C', having indicating-points 2, arranged and operating exactly as described for the corresponding parts shown in Fig. 4. The outer end of said socket is formed to contain a point C^2, being slotted on

one side at c^2 and formed tapered and screw-threaded at its outer end, with a nut C^3 mounted thereon, by which said point C^2 may be locked in place. Said point C^2 may thus be interchanged with other points of ordinary construction when desired.

Instead of a beam of rectangular formation one formed tapered on its sides from back of the flanges of plates B′ and C′, as shown in Fig. 6, may be used if preferred. The angle of taper is such that the sides of the nuts will support the instrument when used as a straight-edge.

FIG. 1.

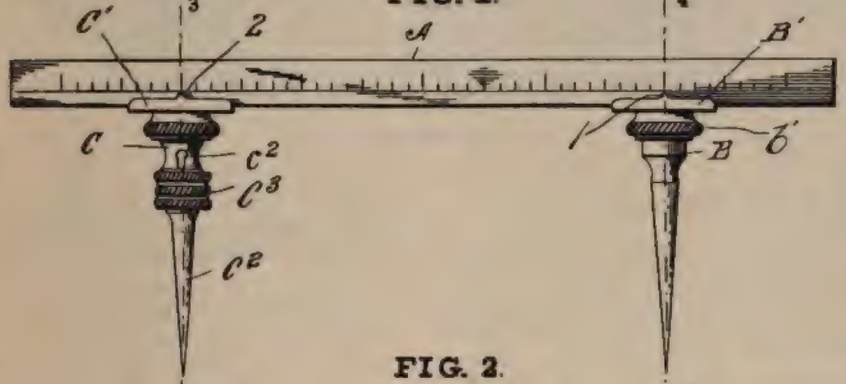


FIG. 2.

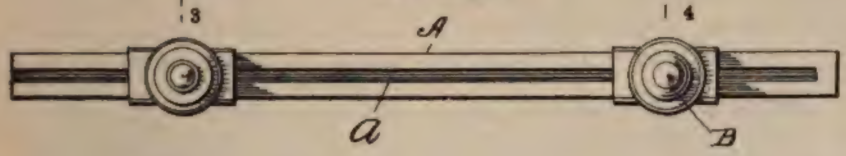


FIG. 3.

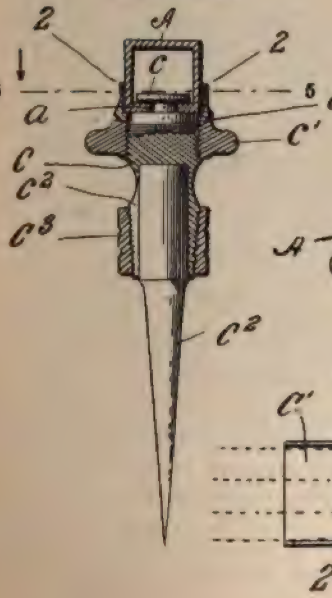


FIG. 4

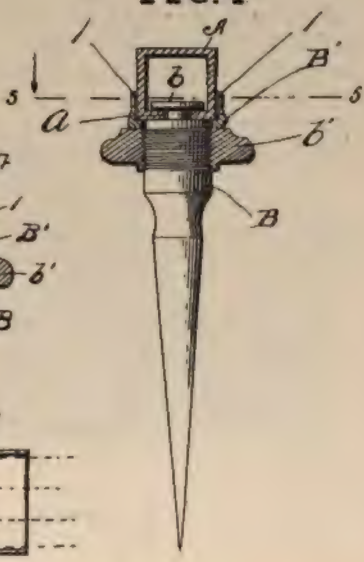


Fig. 6.

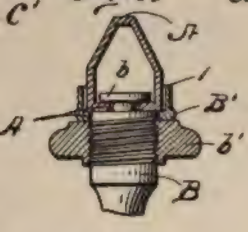
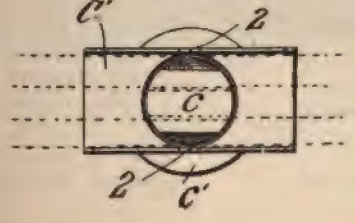


FIG. 5.



QUESTIONS AND ANSWERS.

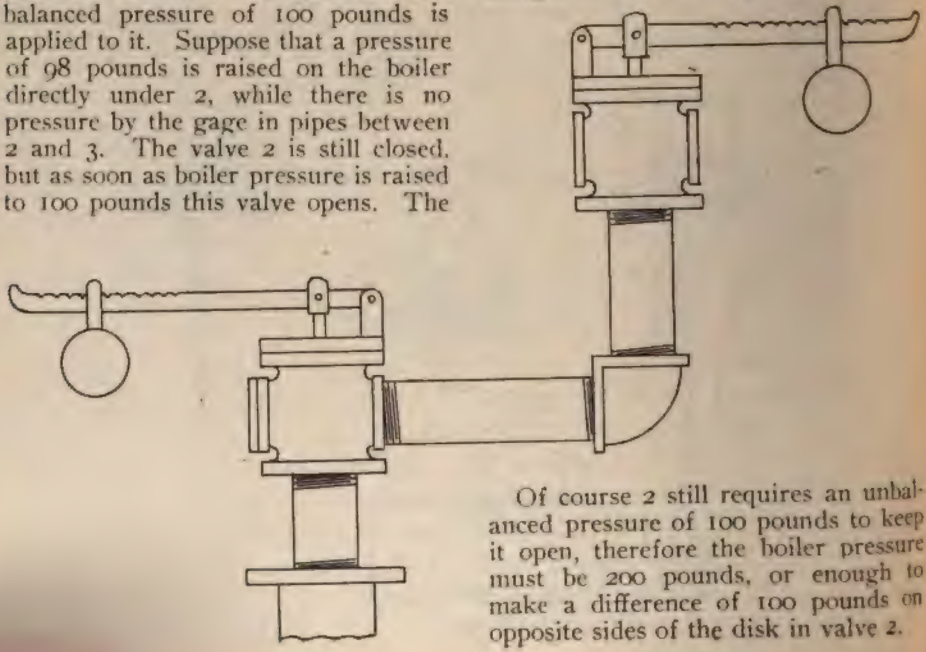
Pressure Required to open safety Valve.

BY W. H. WAKEMAN.

Editor The Draftsman:—

In the accompanying sketch, 2 represents an ordinary lever safety valve set to open at 100 pounds pressure in the boiler. 3 is another safety valve of the same type set to open at 100 pounds, and attached to the outlet of 2 as shown. What boiler pressure will be required to open 3 under given conditions?

A. When a safety valve is set to open at 100 pounds pressure, it means that the disk will lift when an unbalanced pressure of 100 pounds is applied to it. Suppose that a pressure of 98 pounds is raised on the boiler directly under 2, while there is no pressure by the gage in pipes between 2 and 3. The valve 2 is still closed, but as soon as boiler pressure is raised to 100 pounds this valve opens. The escaping steam does not find a free outlet, therefore pressure begins to accumulate in the discharge pipe. Suppose that it is 2 pounds here, while boiler pressure remains at 100. The unbalanced pressure is 98 pounds, which is not sufficient to keep 2 open, therefore it closes. When boiler pressure is raised to 102 pounds 2 opens again, discharges as before and continues the operation until pressure in pipe between the two valves reaches 100 pounds when 3 opens and discharges into the atmosphere.



Of course 2 still requires an unbalanced pressure of 100 pounds to keep it open, therefore the boiler pressure must be 200 pounds, or enough to make a difference of 100 pounds on opposite sides of the disk in valve 2.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Manufacturers Bldg. World's Fair.

MECHANICAL.

Problems in Beams and Planes Severally Supported and Eccentrically Loaded.

C. F. Blake.

Among the troublesome problems that sometimes occur to the designer are the cases of beams carryng a concentrated load, or loads, and borne upon several supports, the reaction upon these supports being required. Such problems, however, may be easily solved by an application of the principles of the polar moment of inertia. Attention has already been called by the writer to the advantages of the application of these principles to the design of riveted joints, but as the usefulness of the polar moment of inertia method is not as well recognized as it should be, a few remarks upon its use in general may not be out of place before appyling the method to the problems in hand.

The general formula for equilibrium under the polar system of co-ordinates is the same as that for the rectangular system with the subscript p added to the proper quantities to denote that they refer to the polar system.

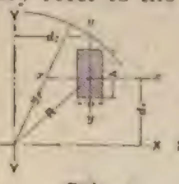


Fig. 1

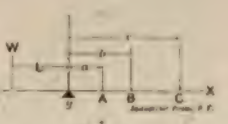


Fig. 2.

$$M = f\frac{I_p}{y_p} = f Z_p \text{ .... } (1)$$

M = the moment about the pole in inch-pounds.
f = the fiber stress upon the most remote fiber from the pole.
y_p = the distance from the pole to the most remote fiber.
I_p = the polar moment of inertia.
Z_p = the polar section modulus.

If, when considering the torsional resistance of any section about a given pole, we draw through that pole a system of rectangular co-ordinates, co-ordinate moments of inertia of the XX and YY, the polar moment of inertia of the section will be the sum of the two co-ordinate moments of inertia about these axes. Thus, referring to Fig. 1, let Ix and Iy be the section about the x and y axes respectively, these axes being drawn through the center of gravity of the section. Then from the well-known formula, the moments of inertia about the axes XX and YY respectively, are:

$$\left.\begin{aligned} I_X &= I_x + A d_2^2 \\ I_Y &= I_y + A d_1^2 \end{aligned}\right\} \text{ where } A = \text{the area of the section.}$$

Then, $$I_p = I_X + I_Y = I_x + I_y + A R^2$$

Where several sections are grouped about a pole, the total moment of the group is the sum of the several polar moments taken separately as above for each secton.

Thus for any number of sections,

$$I_p = \Sigma\,(I_x + I_y + AR^2) \text{ .... } 2$$

and substituting this valve in (1) we have,

$$M = f\,\frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \text{ .... } (3)$$

$$Z_p = \frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \text{ .... } (4)$$

At present we are dealing with loaded points instead of sections, so Ix, Iy, and A approach zero, and (4) reduces to

$$Z_p = \frac{\Sigma A R^2}{y_p} \text{ approximately} \dots\dots\dots (5)$$

From this we see that the torque set up by the reaction of a point is directly proportional to the square of its distance from the axis of rotation, and it is this fact upon which the following solutions depend.

In Fig. 2 let XX be a beam supported at y, loaded by a known load W at a distance L from this support, and prevented from rotating about y by the reaction of several points. A, B and C, distant respectively a, b, and c from the support. Required the reactions A, B and C. The torques of the reactions at the several points on the right of the support are proportional to the squares of their distance from y, therefore the total torque on the right of y is proportional to $(a^2 + b^2 + c^2)$, and the torque obtained from reaction WL, on the left of y.

$$\left.\begin{array}{l} A = \dfrac{a^2}{a^2 + b^2 + c^2} \\ B = \dfrac{b^2}{a^2 + b^2 + c^2} \\ C = \dfrac{c^2}{a^2 + b^2 + c^2} \end{array}\right\} \text{ of the total torque.}$$

Since a force exerting torque about an axle is equal to the torque divided by the arm at which it acts, we have the force

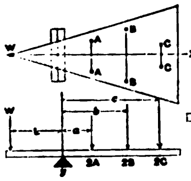
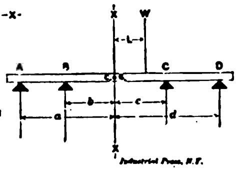


Fig. 3.



Industrial Press, N.Y.

Fig. 4.

$$A = \frac{\dfrac{a^2}{(a^2 + b^2 + c^2)} W L}{a} = \frac{W L a}{a^2 + b^2 + c^2} \dots (6)$$

Likewise the force

$$B = \frac{W L b}{a^2 + b^2 + c^2} \dots\dots\dots (7)$$

and

$$C = \frac{W L c}{a^2 + b^2 + c^2} \dots\dots\dots (8)$$

Thus, having the values of W, L, a, b, and c, we arrive at values for A, B, and C such that, acting through their respective arms a, b, and c, they will balance the force W acting through its arm L.

Having found the values of A, B, and C, the force upon the support y is

$$W + A + B + C.$$

This is applicable no matter how many points of reaction there may be, nor how they are placed, so long as they are symmetrical about a line drawn through W. This is shown in Fig. 3, which represents a plane balanced upon a knife edge, having a load W on the left, and several points of reaction on the right, these points being symmetrically placed about the line $x\,x$. This problem may be treated exactly as that shown in Fig. 2, the resulting load upon the knife edge being uniformly distributed.

If the points are not symmetrical about $x\,x$, the same method may be used, but the resulting load upon the knife edge will not be uniformly distributed. Fig. 4 represents a beam severally supported at A, B, C, and D, and loaded at W. The line $x\,x$ is drawn through the center of gravity of the supports A, B, C, and D. The reaction of each support due to the torque WL is found by formula (6). Note must be made of the directions of these reactions; in Fig. 4 the load W would, in the absence of the supports, rotate the beam clock-wise about the center of gravity, hence the forces A and B are up, and the forces C and D are down. In algebraic addition to these loads at the several supports, each support will have a vertical load

down of $\frac{W}{n}$ pounds, where n is the number of supports.

Thus in Fig. 4 the load at A is

$$A = \frac{W}{n} - \frac{W L a}{a^2 + b^2 + c^2 + d^2} \ldots\ldots\ldots (9)$$

and the load at C is

$$C = \frac{W}{n} + \frac{W L c}{a^2 + b^2 + c^2 + d^2} \ldots\ldots (10)$$

etc., n being 4 in the case of Fig. 4

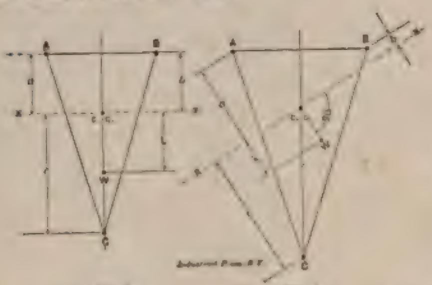


Fig. 5. Fig. 6.

Let Fig. 5 represent a plane severally supported at A, B, and C, and loaded at W; required the reactions at the supports. Locate the axis of rotation $x\,x$ through the center of gravity of the supports. Each support resists a down load of $\frac{W}{n}$, and at the same time a load due to the torque of WL about the axis of rotation $x\,x$, precisely as in Fig. 4, and the same formula (9) may be used.

Fig. 6 is the same as Fig. 5, except the load is not symmetrically placed as regards the supports. Locate the center of gravity of the supports, and connect this with the point of loading W. Through the center of gravity perpendicular to this line draw the axis of rotation $x\,x$. From each point of support drop a perpendicular to $x\;x$, thus getting the arms at which the reactions act. The reactions at the supports may now be obtained by formula (9). The method of Fig. 6 is applicable to any plane severally supported and loaded, since W may represent the center of gravity of any number of known loads upon the plane, and the formula may be extended for any number of supports.

A graphical solution for formula (9) sometimes convenient is as follows: In Fig. 7 draw the rectangular axes xx and yy, and and lay off a unit of the selected scale on xx. Also on xx lay off the arms at which the reactions act, a, b, and c, obtaining points A, B, and C. At these points erect perpendiculars, and also through these points pass arcs $A1$, $B3$ and $C5$, with o as center. Through the points 1, 3, 5, where these arcs cut the perpendicular from the unit point, pass radial lines from o, and extend them to meet the respective perpendicular from A, B, and C at points 2, 4, and 6 respectively. Then

$$\frac{o\,1}{\text{unit}} = \frac{o\,2}{o\,A}$$

and since the unit equals 1, and $oA = o1 = a$, we have

$$\frac{a}{1} = \frac{o\,2}{a},\ o\,2 = a^2.$$

Likewise $o4 = b^2$ and $o6 = c^2$. With a radius equal to L, describe an arc cutting the unit perpendicular at 7, and draw a radical line through this point to cut lines from A, B, and C in 8, 9, and 10. Then $o8 = La$, $o9 = Lb$, and $o10 = Lc$.

Having found the lines representing a^2, b^2 and c^2, set the dividers to a radius equal to the sum of these lines, and with an arc cut the unit perpendicular at H. Draw oH. Transfer points 8, 9, and 10 to 8′, 9′, and 10′ on line oH by means of arcs struck from o, and from the latter points drop perperpendiculars. The distances a', b', and c', when measured to the adopted

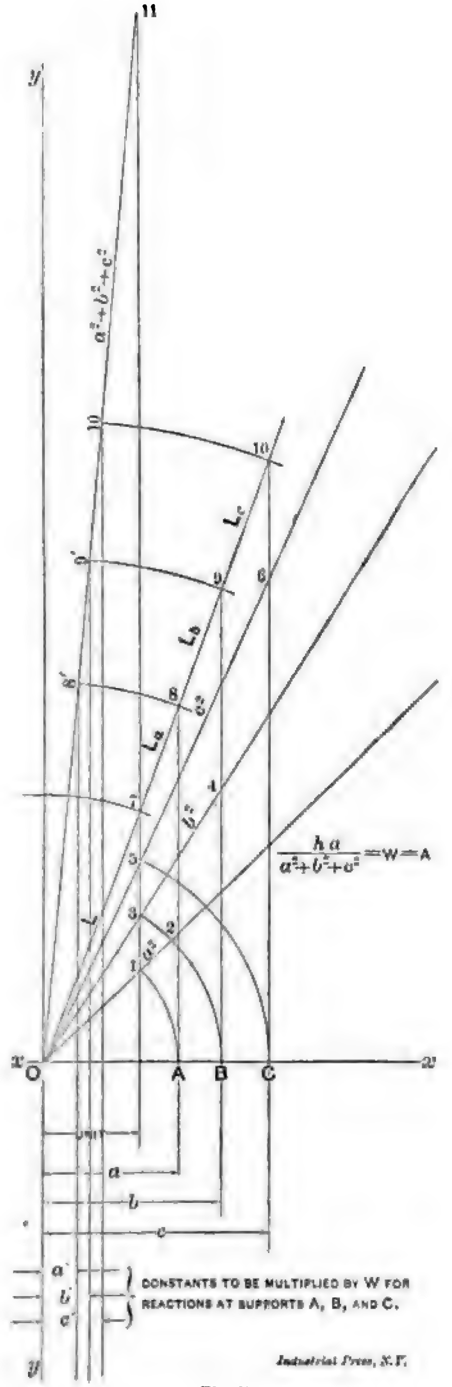


Fig. 7.

scale, and multiplied by W give the reactions at A, B, and C respectively.

Like the formula, this diagram may be extended to cover any number of points of reaction. As in all written descriptions of graphical methods, the actual work required is far short of what seems necessary when first read, and is in reality very simple. The range of problems to which this method is applicable is very great, including the loads carried by machinery foundations, car loadings, beams, anchor plates, and many intricate details of machine design, in short any problem, no matter how intricate, that may be reduced to a plane supported upon several points, and carrying one or more loads, the center of gravity of which is known. The following problem will serve as an illustration:

Fig. 8 represents a four-legged spider or anchor plate, loaded as shown; the arms being of varying lengths we require the reaction at each support, in order to proportion the arm sections.

Draw $B\ C$ and bisect it at e, also bisect $A\ D$ at f. Join e and f, and bisect ef at g. Then g is the center of gravity of the supports A, B, C, and D if the load on each one is unity. Draw $o\ g$, and $x\ x$ perpendicular thereto, and upon $x\ x$ drop perpendiculars from A, B, C, and D.

We then have from formula (6),

$$\text{Load at } A = \frac{1000 \times 1.75 \times 10.5}{(10.5^2 + 3.25^2 + 11^2 + 8.75^2)} = 71.9 \text{ lbs. downward.}$$

$$\text{Load at } B = \frac{1000 \times 1.75 \times 3.25}{(10.5^2 + 3.25^2 + 11^2 + 8.75^2)} = 22.14 \text{ lbs. downward.}$$

$$\text{Load at } C = \frac{1000 \times 1.75 \times 11}{(10.5^2 + 3.25^2 + 11^2 + 8.75^2)} = 75.25 \text{ lbs. upwards.}$$

$$\text{Load at } D = \frac{1000 \times 1.75 \times 8.75}{(10.5^2 + 3.25^2 + 11^2 + 8.75^2)} = 25.68 \text{ lbs. upwards.}$$

1000 lbs. × 1.75 inch lbs. = 1750 inch lbs.

71 9 × 10.5 = 734 96 inch lbs.
22.14 × 3.25 = 71.955
75.85 × 11 = 828.850
25.68 × 3.75 = 96.112

1751.867 inch lbs. check.

Vertical load on each arm = $\frac{1000}{4}$ = 250 lbs. downward

Resultant on A = 250 + 71.9 = 321 9
" " B = 250 + 22.14 = 272.14
" " C = 250 − 75.85 = 174.65
" " D = 250 − 25.68 = 224 37

1098.06 lbs. check.

The error, less than ten per cent, arises from dropping decimals in taking squares, and from slide rule readings, but the check is as close as practice demands.

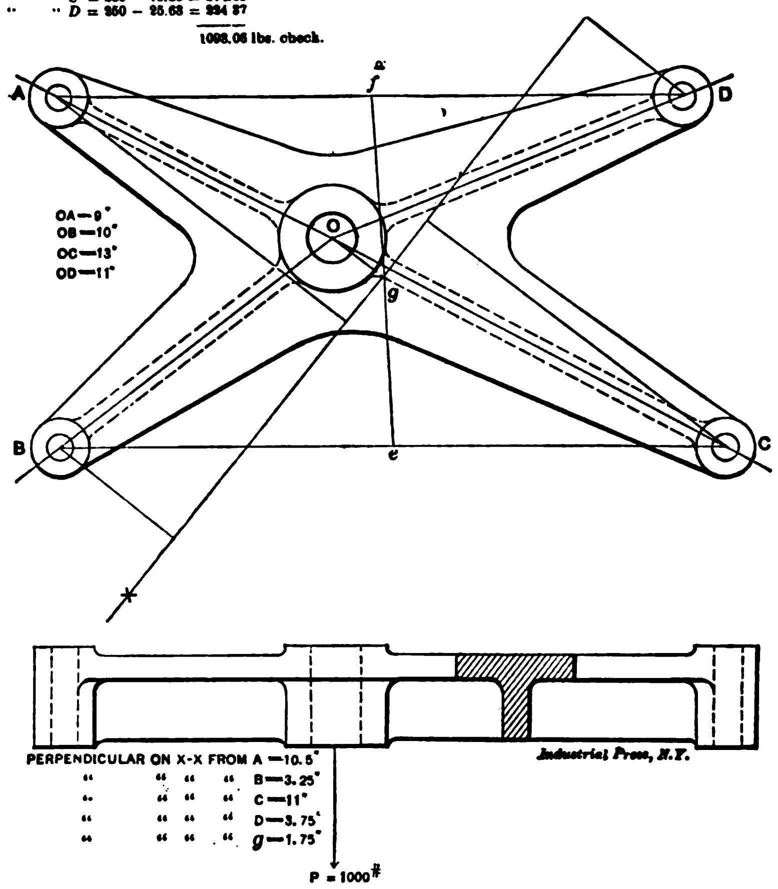
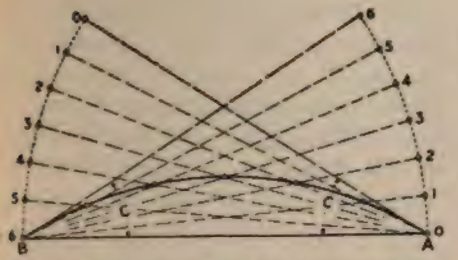


Fig. 8.

A Neat Method of Plottinga Curve of Large Radius.

A writer to *Engineering News* says, "Sir: The recent publication of several methods of drawing the parabola leads me to send you this note on the circle. Experience in the drawing-room shows that draftsmen are often puzzled as to the means of drawing a circular arc of radius too large for the beam compass or a "railroad" curve. The following method has proven satisfactory.

Let A B be a chord of the required arc. At each end of this draw a tangent, the angle C being computed from the formula $\sin C = \frac{\frac{1}{2} \text{ chord}}{\text{Radius}}$; from A and B as centers drawn arcs BO



and A6, intersecting the tangents; divide these arcs into any number of equal parts and number them in reverse order, as shown; draw the series of radial lines from A and B. The intersection of A1 with B1 will give a point on the required arc, as will also that of A2 with B2, and so on for the other pairs of radii. A spline or a steel straight-edge (placed edgewise to the paper) may then be sprung so as to pass through the points, and the curve drawn along the edge.

Very truly yours,
Frank T. Daniels,
No. 1 Ashburton Place.

Tooth Gearing, The Elliptic Gear.

The principal and almost the only use of the irregular gear is to produce a variation of speed between given limits without conditions as to the variations of speed between these limits being known.

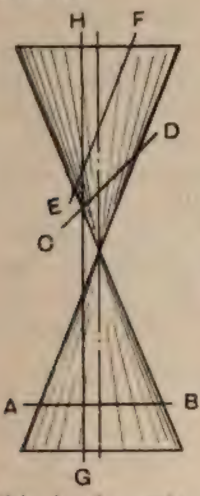


Fig. 1

When this is the only object, the elliptic pitch line is the only one that is required and it is chosen because it is the only known continuous closed curve that will work in rolling contact with an equal mate.

Next to the circle it is the simplest known curve and when used is arranged to revolve on one of its foci as a center.

The use of the elliptic gear is practically confined to producing a simple variation of speed between known limits and to produce a "quick return motion" for planers, shapers, slotters, shears, punches, shingle machines and others where the work is done mostly during one half of the stroke of a reciprocating part.

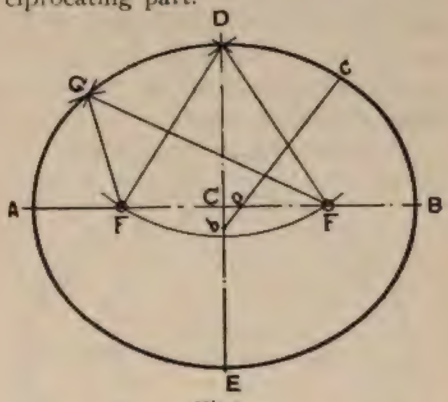


Fig2.

A definition of the elliptic is that it is one of the "conic sections." If a cone Fig. 1 is cut by a plane A B at right angles with its axis, the outline of the section will be a circle.

If the plane CD cut the cone at an angle, the section is an ellipse. If the plane EF is parallel with a side of the cone, the section is a parabola and if the plane GH is at such an angle that it cuts both nappes of the cone, the section is a hyperbola. All the curves will roll together when fixed on centers at certain points called foci but the

ellipse and the circle are the only ones that permit of continuous motion.

In the ellipse Fig. 2 the point C is the center, the longest diameter AB is the *major* axis, the shortest diameter DE is the *minor* axis; A and B are the major apices and E and D are the minor apices.

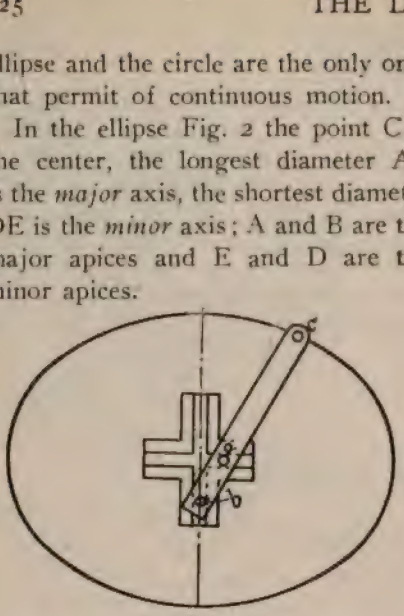


Fig. 3.

An arc drawn from the minor apex with a radius equal to half the major axis will cut the major axis at the point F and F' called the foci and one focus must be taken as the center about which the curve is to revolve, if used as the putch line of a gear.

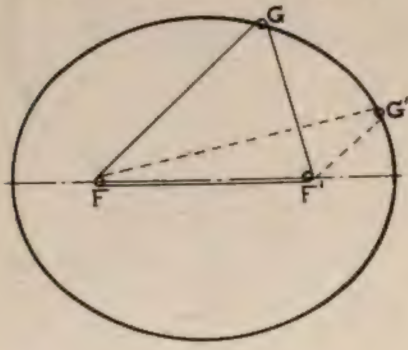


Fig. 4.

It is a characteristic of this curve that the sum of the distance GF and GF' from any point G to the foci is equal to the major axis AB and this is used as a means of constructing the curve by points.

Draw an arc from one foci with a radius FG, then subtract its length from AB and the remainder will be the length of line F'G. Hence it will be readily seen that if only AB is known and the location of F and F' and F'D are equal and each one half of AB, thus giving the length DE.

Another valuable property of the ellipse is that if the line bac is so drawn that the distance ca is equal to Ce and cb to Ac, the point c will be upon the curve if the points a and b are upon the axis.

Upon this principle an instrument called a trammel is made to describe the ellipse, Fig. 3.

Other elliptographs have been tried but the simplest one consists of a couple of pins, a thread and a pencil.

The pins are inserted at the foci, as in Fig. 4 and the curve is drawn by moving the pencil with a uniform stress on the string but this method should not be relied upon when accuracy is desired.

The radius of curvature at either apex, that is, the radius of the circle that most nearly coincides with the curve is found by the following approximate method and it is quite accurate where the ratio of axes is not less than eight to ten.

Draw the major and minor axis at right angles to each other and draw the line CB, Fig. 5.

With O as a center, draw arc from C and lay off C2 on CB equal to the difference between half the major and half the minor axis.

Bisect 2B with line 34 and produce it to cut both axes. Then make O5 and O6 equal to O3 and O4 respectively and use 3, 4, 5 and 6 as the centers of the curves.

These centers will be used for

circles at point and root of the teeth and for the base circle in involute teeth.

ROLLING ELLIPSES.

When two equal ellipses Fig. 6 are arranged to revolve on their foci as centers with a center distance equal to the major axis they will roll together perfectly and can serve as the pitch lines of gears.

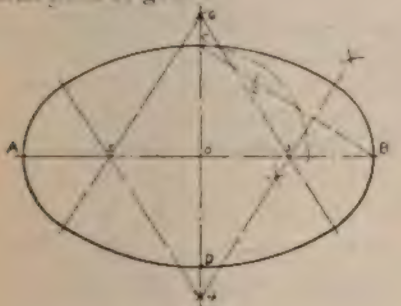


Fig. 5.

As the ellipses roll together, it is essential that the axis come in line and therefore if the teeth of one gear are fixed at random, those of the other must be placed to correspond. It is very desirable that the gears be exactly alike so that in the case of cut gears they could both be mounted together on the same arbor and one operation do for both if the number of teeth are even and they start at the same point.

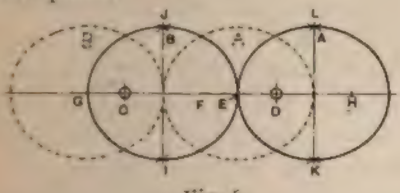


Fig. 6.

If the number is odd, the major axis must bisect a tooth and a space, and in this case the gears can be turned over or if its other foci can be used as a center, it may have a tooth from the major axis as at *a* Fig. 7.

The best way of spacing the ellipse is to step about it with the dividers. If the curve is flat, the dividers should be set slightly less than a whole tooth for equal chords will not measure equal arcs of the curve and it is suggested that some better method be obtained for mechanical purposes.

As in the case of the circular gear the form of tooth may be either cycloidal or involute, the latter being the best for the same reasons as with a circular pitch line.

The curve of the face and flank of the tooth may be laid out in accord with methods laid down for cycloidal or involute curves.

A PRACTICAL CASE.

Two ellipitical gears are to run together with a velocity of 3 to ⅓, the major axis being 8 inches.

If as in Fig. 6, the gears are placed as shown by the heavy lines, gear A will be turning three times as fast as B and B only one third as fast as A.

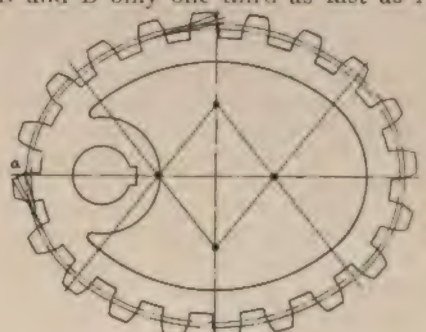


Fig. 7.

When the gears have assumed the position as indicated by the dotted lines A will be going one third as fast as in its previous position and B three times as fast as before.

Then CE will be three times as long as DE and since the distance between foci is equal to the major axis which

in this case is 8", then CD will be divided into four equal parts, three for gear B and one for gear A. CE will become 6" and ED will be 2".

Draw the line for the position of the minor axis at the center of the major axis.

As stated before DL and HL are each equal to one half the major axis or in this case 4", and with compass set at H and D, strike arcs K and L with a radius of 4".

Draw a pair of ellipses with major and minor axis by means of the trammel, the string or four point circle method.

If the ratio of speed was from 4 to 1/4 then the distance from center to center (C to D) would have to be divided into five parts. If 2 to 5, then DE would be 2-5 of CE.

CHILL ROLLS.

In an article, "Chill' Rolls," in the *Iron Age*, Mr. B. E. V. Luty says that the standard dimensions of tinplate rolls in this country are 26 inches diameter, 32 inches long in the body and 20 inches diameter in the necks. The depth of chill is about 7/8 inch, but it was formerly only 1/2 to 5/8 inch. The life of a chill roll is only from 90 to 120 actual working days for tinplate or ordinary sheet rolling, running at 30 revolutions per minute. But many good rolls are broken before they are worn out. The reasons for breaking are somewhat indeterminate, although they may be included under three heads: 1. Casting strains. 2. Excessive pressure on the roll from the material being worked. 3. Heat strains produced in the roll by irregular working. While theoretically the pressure necessary to break rolls by excessive pressure is something enormous, they are frequently broken in this way. It is calculated by the formula

$$W = \frac{4f}{l}\,0.0982d^3 \text{ in which}$$

W = load in pounds, applied at the center,
f = fiber strength
l = distance between supports
d = diameter
so that on a standard roll the load applied to the center necessary to break it would be 2,887,000 pounds, taking the fiber strength to be 20,000 pounds per square inch.

Shrinkage of Castings.

H. C. TULLY.

Agricultural implement shops to get better foundry fits draw cast details to single (12 1/8") or double (12 1/4") shrink scale on heavy paper. In this way, the patternmaker gets an undimensioned picture which he does not like as it seems to reflect on his ability to have drafting rooms show him what size to make the pattern.

About 99% of the drawings are 12 1/4" scale as an implement foundry make short work of a wood pattern so that 12 1/8" scale is only used when no metal pattern will be needed.

A new metal placed on the market by an English firm as a substitute for nickel is said to possess advantages over nickel plated goods. It is silver white through and through, and, it is claimed, keeps its brilliance permanently and will not rust under most unfavorable conditions. Malleable to a degree when cold, it is easy to solder and braze, the flux being ordinary soldering water and borax.

ELECTRICAL.

Transformer Design

core loss may represent quite a large part of the total energy. Thus for infrequent service a transformer designed with a low core loss is the only acceptable one. Its copper losses on the other hand may be quite high since they cease as soon as the load is taken off.

(c) The voltage and frequency at which the transformer is to be used are also important matters in its design. The ratio of the voltages of the primary and secondary determines the ratio of the primary and secondary turns, while the greatest difference of potential connected with the transformer determines the insulation necessary. The frequency, has a large influence on the size of the transformer and its core losses.

We will now suppose that the designer has investigated all of the conditions mentioned above and is ready to proceed with his calculations. He may choose one of two general classes of design: First, the shell type of transformer having a divided magnetic circuit in which the iron is placed around the coils as shown in Fig 1, or second, the core type having but a single magnetic circuit, and having an iron core inside of the winding as shown in Fig. 2. The first mentioned class contains more iron and consequently presents a greater radiating surface. This means that with the same loss of energy, the shell type transformer will operate with a less increase of temperature than the core type. On the other hand, the core type, containing less iron, will operate with a smaller loss of energy due to hysteresis and eddy currents since these losses increase directly with the volume of the iron.

Having chosen the type of transformer, the designer is now ready to proceed with his calculations. He must keep the following points in mind: The efficiencies, the regulation, heating, insulation, and cost. The conditions known are, the ratio of transformation, the character of the work for which the transformer is to be used, the frequency and voltage at which it is to operate, and the capacity required.

The first thing to be determined is the total magnetic flux, or the total number of lines of force in the magnetic circuit.

Assume T = number of turns in the primary in series. Then the flux

The designer must now choose the flux density or number of lines of force per sq. in. = B. He does this by inspecting a table giving values for B corresponding to different conditions of service.

Having decided on the value of B, the cross section area of the magnetic circuit A = is determined. He may now lay out this section.

Since the ratio of transformation is known, the number of turns of wire in the secondary is obtained.

The current density at full load must now be chosen. This will vary in value between 1000 and 2000 C. M. per ampere, depending on the specifications for the transformer. In any case the current density chosen should be such that the heat distribution shall be the same throughout the two coils. Knowing the current density the size of wire to be used in winding both primary and secondary coils is obtained from a wire table and the space

occupied by the coils calculated.

The designer can now calculate the length of the magnetic circuit and the volume of iron to be used; he may also decide on the shape and thickness of the stampings, allowance being made for proper insulation and ventilation. This being done the core loss due to hysteresis may be determined as follows:

The loss from eddy currents is calculated in the following manner:

The total iron loss will, of course, be the sum of these two losses, or,

In order to calculate the efficiency, the total loss in the transformer must be known. This, in addition to the iron losses, includes the I_2R losses in both primary and secondary.

where K = capacity of the transformer in watts. The all day efficiency of the transformer is very important. In order to calculate the all day efficiency, the designer must know the number of hours each day that the transformer is used. The iron loss will be constant, being independent of the load, but the copper loss will depend directly on the amount of power used.

The all day efficiency will be the ratio of the watt hours taken out of the transformer to the ratio of the watt hours supplied to the transformer for a period of 24 hours.

In order to determine the regulation or drop at full load, the designer must know the drop in both primary and secondary, the drop in the primary being reduced to the secondary by dividing by the ratio of transformation,

This formula does not take into account the leakage drop, which is so small that it may be neglected without introducing any appreciable error.

If the transformer is to be of the self cooling type the heating is taken care of by designing the transformer case so as to present a sufficient radiating surface. It is ordinary practice to allow about 4 sq. in. of surface per watt radiated. Since all the losses of the transformer appear as heat, the minimum value for the radiating surface of the transformer in sq. in. = (core loss + copper loss)4.

The values for efficiency, regulation and heating thus found must check with the values given in the transformer specifications. Otherwise the designer will have to readjust his assumptions until he has obtained the required result.

Electric Furnace Perfected

Practical laboratory work in chemistry will be revolutionized, it is believed, by an electric furnace just perfected by Prof. Harmon V. Morse, professor of analytical chemistry at Johns Hopkins university and adjunct director of the chemical laboratory. The furnace is the result of long and hard work on the part of Prof. Morse, and his invention is one of the important scientific achievements of the year.

Prof. Morse's furnace was shown before the chemical seminary at a recent meeting of the university. He

and his young assistant, Dr. J. C. W. Frazer, were congratulated by President Remsen and the scientific faculty, to whom he spoke for an hour about the apparatus.

Heretofore gas has been the only source of heat for experimental work in the chemical laboratory. For a long time scientists have been trying to devise some sort of economical electric heater. That satisfactiory results may be obtained in the heating necessary in laboratory practice four conditions must be satisfied: (1) The heat must be developed economically; (2) it must be possible to obtain definite temperatures; (3) it must be possible to maintain constant temperatures for long periods; (4) products of combustion must not be allowed to come in contact with the substances heated.

Chemists have long since seen that the solution of this problem was to be found in the electric current, which yields no products of combustion and can be developed at a constant and regular rate. Thus far, however, no one had been able to make it a practical substitute for gas.

Prof. Morse's electric heater comprises first, an ordinary copper oven incased in a box, doubly lined with an air space between, the whole covered with aluminium paint, which is not affected by high temperatures, is a poor heat radiator, and preserves the asbestos from shredding. This arrangement practically prevents any loss of heat by radiation.

The source of heat is in the stove placed within the copper oven. The stove is constructed of parallel slabs of soapstone coated with graphite, the soapstone being unaffected by heat. The graphite is evenly distributed over the slabs of soapstone, that the heat may be developed uniformly over the surface. The use of soapstone in constructing the heater is the key to the apparatus.

The electric furnace has been found to work admirably, and can be operated at a cost of less than 1 cent a day. A constant temperature of 150 degrees can be obtained for eight hours at a cost of three-fourths of a cent. It is probable that Prof. Morse's furnace will displace the old gas furnaces now in general use, and it is certain that it will add much to the exactness with which chemical processes may be carried out.

After long controversy as to the merits of the steam turbine the navy will soon install its first engine of this pattern in the Charleston navy yard at Boston, to supply power and light about the yards and to such ships in the docks as require an electric current.

POWER PLANTS OF SPAIN.

It is estimated that there are at the present time in Spain over 1,000 works generating electric current for lighting and power, and that over 2,000 generating sets are installed. Many of the companies working these electricity undertakings are using water power. Two of the companies established in Bilbao are now engaged endeavoring to utilize 20,000 horse power from neighboring waterfalls for the town supply. This is in addition to the steam plant used by five companies already engaged in supplying electric current.

ARCHITECTURAL.

A System For The Architect.

How the drawings and prints may be filed and indexed for ready reference, and how a record may be kept of material that is loaned.

BY ANNA WALTERS.

For an architect's office in a city with a population ranging from 10,000 to 50,000 the following system has been found to fill all requirements:

The plans are first classified under the headings of residences, schools, stores and offices and public buildings, according to the architect's desire. The residences are then numbered consecutively, from 1 up, as found necessary; the schools from 500 up, stores from 1,000 up, and so forth. The residences are placed in drawers marked 1, 2, 3, 4, and so on; the schools in drawers marked 5, 6, 7, 8 and 9; the stores in drawers marked 10, 11, 12, and so on.

The plans are placed in heavy manila paper envelopes of uniform size, 16 x 24 inches for residences and 20 x 30 inches for schools and larger buildings. These sizes will accommodate, without folding, almost any set of drawings made in the quarter scale. On the upper left-hand corner of each envelope is placed the drawer number, serial number and the name of the client.

These envelopes keep the plans from all dust and manifold handling, hence it is impossible for any one plan or set of drawings to become confused with another.

For the purpose of indexing these drawings, a card index is the easiest and most satisfactory. The guide cards bear the headings, residences, schools, stores, and whatever else the architect desires to list. Under each of these headings is an alphabetical index, arranged according to the names of the clients. On these cards any amount of information about each set of plans may be placed, according to the will of the user. If, for example, the architect wants to find the residence of "Wm. Green," he will look under the heading residences, and under the letter "G" find the name Green. The drawer and serial number are seen at a glance, 4 and 200. The envelope, 200, may be easily removed from the drawer, although it be at the bottom, without disarranging any other plan or set of plans.

In this way many plans may be filed away in a small space.

The following short-cut will be found very satisfactory in keeping account of the sets of blue prints issued on any piece of work:

A small blank book (or, if desired, an extra card slipped in back of the

main card in the index may be used)
8—Draftsman—Fifner 22 22
should be ruled as shown in Figure I.

For example, four sets of blue prints are issued for the residence of William Green. East set is consecutively numbered from 1 to 4. Mr. Arnold, a contractor, comes in and wishes a set of prints. His name and the number of the set given him are indicated in their respective columns, together with the date they are taken out of the office and when they are to be returned. In case there are no sets in stock, a date may be placed in the "Promised" column when there will be a set at his disposal. In this way an architect may tell at a glance where each set of blue prints is, and each set will be returned.

Often a contractor, or one who has taken a set of plans out of the office, will forget to return it, and the architect or his employe will forget to whom a particular set was given. Th often causes much annoyance and loss Under this system none of the above errors can occur.

Another short-cut for filing circulars will be found very convenient:

An architect receives daily many ad-

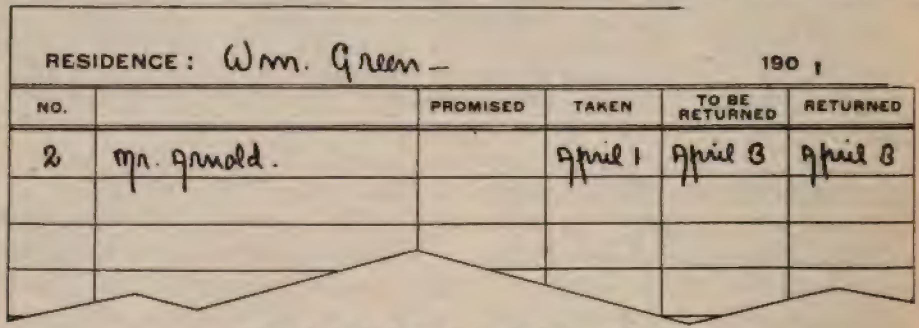


Figure I; the "follow-up" record of property loaned

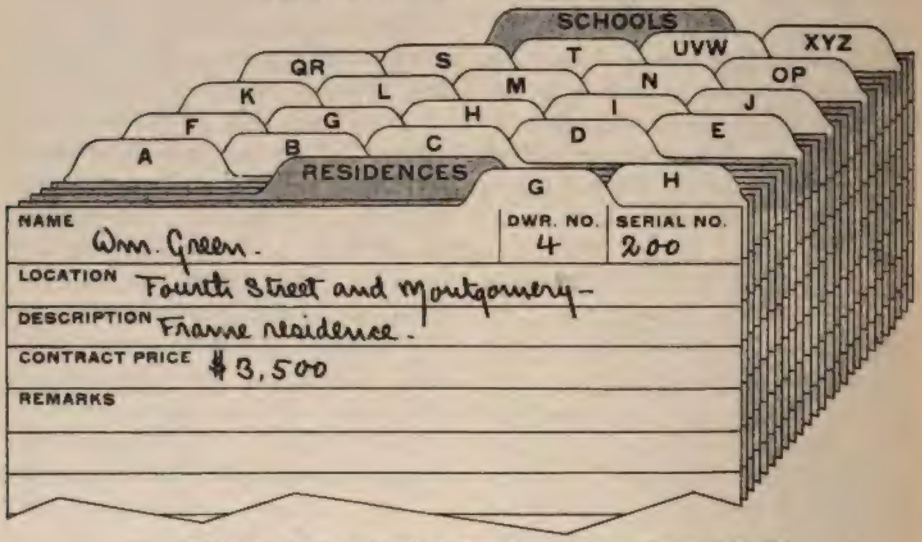


Figure II; the index for the architect's drawings, showing the arrangement of the guide

vertising pamphlets, circulars and business cards to which he often may want reference. By using letter files, each labeled properly, these loose cards and circulars may be kept in compact and easily accessible form. Each separate file is labeled paints, glass or hardware, as the case may be. As a circular comes in, it is placed away in the proper file, where it may be easily found when wanted.

"System."

Discolorations on Brickwork.

Trautwine gives the following excellent discussion on this subject which is of some little interest and importance both to Architects and Engineers.

The white efflorescence so common on walls, especially on those of brick, is due to the presence of soluble salts in the brick and motar. These are dissolved, and carried to the face of the wall, by rain and other moisture. Sulphate of magnesia (Epsom Salt) appears to be the most frequent cause of the disfiguration. In many places mortar lime is made from dolomite, or magnesian limestone, which often contains 30 per cent or more of magnesia; which also occurs frequently in brick clay. Coal generally contains sulphur, most frequently in combination with irón, forming the well-known "iron pyrites." The combustion of the coal, as in burning the limestone or clay, in manufacturers, in cooking, etc., converts the sulphur into sulphurous acid gas, which, when in contact with magnesia and air, as in the lime or brick kiln, or in the finished wall or chimney, becomes sulphuric acid and unites with the magnesia, forming the soluble sulphate. We are not aware of any remedy that will prevent its appearance under such circumstances; but the formation of the sulphate may be prevented by the use of limestone and brick-clay free from magnesia.

The common (not Portland) cements, when used as mortar for brickwork, often disfigure it, especially near sea coasts, and in damp climates, by white efflorescence which sometimes spread over the entire exposed face of the work, and also injure the bricks. This also occurs in stone masonry, but to a much less extent, and is confined to the mortar joints; and injures only porous stone. It is usually a hydrous carbonate of soda or of potash often containing other salts. General Gillmore recommends as a preventive to add to every 300 lbs. (1 barrel) of the cement powder, 100 lbs. of quicklime, and from 8 to 12 lbs. of any cehap animal fat. The fat to be well incorporated with the quicklime before slacking it preparatory to adding it to the cement. This addition will retard the setting, and somewhat diminish the strength of the cement. It is also said by others that linseed oil at the rate of 2 gallons to 300 lbs. of dry cement, either with or without lime, will in all exposures prevent effflorescence, but like the fat it greatly retards setting, and weakens.

Read the Want Columns, Page 10.

HOME STUDY.

Mechanics.

CHAPTER I.

In beginning the study of Mechanics, it is necessary to get an exact idea of the meaning of the terms with which it deals. Some of the expressions used here are the same as in physics, but in these lessons they will be given a somewhat more specialized meaning and the examples given below are planned to show their application in actual problems.

Mechanics is the science which treats of bodies with respect to their mutual and relative motions. Mechanics of engineering deals only with bodies that are of importance to the practice of engineering.

Matter. According to physics, whatever occupies space is called matter; in the mechanics of engineering it is the material upon which we work. For example, stone, iron, water, etc.

Mass is the quantity of matter in a body. As used by most technical writers, it is the weight divided by the acceleration of gravity, or in symbols $M = G \div g$, which is always a constant. Mass does not mean the bigness of a body as used in the popular sense, neither is it the weight as will be seen by the formula. A pound of feathers is bigger than a pound of lead ordinarily, yet their masses taken at the same locality would be equal. The size of a body will vary with its temperature and the weight will vary with the location on the earth's surface, but G and g vary together for any location and the quotient M becomes constant and is for that reason a more convenient expression to use.

Volume is the bigness of a body or the amount of space occupied by it.

Weight is the pull or force exerted upon a body due to the earth's attraction. It is therefore a measure of the force of gravity.

Heaviness is the weight *per cubic unit* of a substance. It may be asked in regard to a body, "How heavy is it?" What is meant is, what is the total weight? A lump of iron may have a total weight of twenty five pounds but its heaviness or rate of weight will be about a quarter of a pound per cubic inch.

Specific Gravity is the ratio of the heaviness of any substance to that of water. The specific gravity of water is taken as unity, and that of any other substance is expressed as a decimal. Tables of the weight and specific gravity of substances can be found in the hand books of enginering.

Motion is a relative term and means the change of position of any particular body with respect to other bodies. Newton's three laws of motion should be learned but they will not be repeated here.

Force is an impressed action upon a

body which tends to change its state of motion or its shape, for example, pressure, attraction, repulsion, etc.

Lift a 10-pound weight and the pull exerted is a force which tends to move the body. The muscular sensation in the arm conveys an idea of force and if a spring balance is put between the hand and the weight, the reading on the scale, ten pounds is the measure of the force.

It is well to train the mind to think of all substances as being made up of an indefinite number of infinitely small particles, forces of attraction and repulsion being always in operation between these particles, something as the earth attracts by the force of gravity all objects upon its surface.

Stress is a force action upon a body which tends to change its shape by distorting the particles of which it is composed or by changing their relative positions.

Strain is the distortion of a body due to the changing shape or position of its particles. There has been some confusion in the use of the terms stress and strain. One is a cause the other an effect. They have improperly been used as synonymous expressions.

Elasticity is the property, which most substances possess, of returning to their original shape after being strained.

1. A body weighs one ton at the earth's equator at sea level. How much will it weigh at the North pole or at an altitude of 5,000 feet?

2. How many cubic feet are there in a ton of soft coal?

3. How many quarts and gallons are there in a cubic foot of water?

4. Find the weight of a cast iron water pipe 16″ in diameter and 12′ long. The pipe is 1″ thick and the bell end is 6″ long; has an average thickness of 2″ and a diameter of 18″.

5. What is the specific gravity of a mixture composed of 20% of iron ore and the rest sand?

6. Write out and explain Newton's three laws of motion.

7. If the wind exerts a pressure of 20 lbs. per square foot on a building which is 50′ long and 20′ high, what is the force tending to move the building?

8. A force of two thousand pounds is applied to the ends of a steel rod ½″ in diameter tending to pull it apart. What is the unit stress?

9. How much would a steel rod ten feet long and one inch in diameter stretch before it would break?

10. Which is the more elastic steel or concrete?

Symbols used in this chapter:

M=Mass.

G=weight in pounds.

g=acceleration of gravity=32.2.

Sheet Iron Ventilators.

The dimensions of sheet iron ventilators here given are some taken from a book of standards of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. Two styles are used, with and without a damper and the table shows the changes, also for the different pitches of roof. The size of posts and stiffening bars are the same.

Dimensions are in inches and the weights are in pounds.

The End in View.

BY PROF. A. EDWARD RHODES.

To obtain satisfactory results in any undertaking, we must aim to obtain a certain end. That is, we never make a drawing without having some definite object in view. It may be only a pleasant way of passing an idle hour, a desire to make a work of art, a desire for self-culture, or that drawing may be wanted for some one of the many commercial purposes. If the object is self-culture or if it is the teaching of mechanical drawing, it seems to me that a teacher friend of mine has nearly the right idea in the following outline of the course he teaches.

It will be seen that the day school opens he knows what he wants to teach at any lesson at any time during the school term, and also what is more important he knows what he wants to have accomplished at the end of the school year. For many schools the course would not be considered the ideal one, but this teacher's students are expected to have only a " smattering knowledge " of a great many fundamental principles rather than thorough knowledge of a few principles. Therefore, for this school it is just what he needs.

OUTLINE OF A COURSE IN MECHANICAL DRAWING.

Sheet No. 1.—Straight, horizontal, vertical and oblique lines.

Object.— To learn names of, and how to draw lines.

Sheet No. 2.— Straight and curved lines.

Object.— Learn names of, and how to draw lines, and necessity of accurate measurements.

Sheet No. 3.— Geometric Constructions.

Object.— Study of perpendiculars, and how to bisect a given line.

Sheet No. 4.— Geometric Constructions, as perpendiculars, polygons, etc.

Object.— Learning to measure with instruments.

Sheet No. 5.— Working drawing of point, line, and rectangular block.

Object.— Learn names and position of the several views and the study of shade lines in working drawings.

Sheet No. 6.— Working drawings of triangular prism with a square hole through it lengthwise.

Object.— Study of invisible edges.

Sheet No. 7.— Two views each of a square prism with a square hole; a square prism with a smaller square prism on top. A cylinder with a round hole, a cylinder with a smaller one on top.

Object.— Same as last.

Sheet No. 8.— Sheet of letters.

Object.— Study of simple letters suitable for working drawings.

Sheet No. 9.— Isometric drawing of small house and table.

Object.— To show a method of representing objects approximately as they appear to the eye.

Sheet No. 10.— Perspective drawing of columns of various heights and of a tiled floor.

Object.— Study of vanishing points and perspective measurements.

Sheet No. 11.— Perspective drawing of room with windows, tiled floor and door.

Object.— Same as No. 10.

Sheet. No. 12.— Perspective of board fence with student's name on it.

Object.— Same as No. 10.

Sheet No. 13.— Perspective of principle lines of row of houses.

Object.— Same as No. 10.

Sheet No. 14.— Perspective of house,

[illegible]

Elementary Course In Mechanical Drawing.

(Contiued from July Issue.)

In some drafting offices a drawing is made of an object with letters instead of figures in the dimension places and a table made with the dimensions of several sizes of machines to go with the diagram.

The illustration and table is of an engine crosshead and the student is requested to make a drawing and tracing with the dimensions in their proper places for the size 7x8 and make it full size, or he can make size 13x16 and make it half size. This is done where some of the sizes have been figured out ahead of the drawings and the latter to be made when needed.

This dimensioned tracing would then be checked, a blue print made and that sent to the shop.

"Checking" is the careful inspection of the drawing as to correctness of figures, proportions, etc., and should be done by someone well acquainted with the work.

Plate XXV.

This plate is to be the title page, to be fastened over the front of all the plates when the student has finished the course.

The sheet should be trimmed to 14x19 but a margin may be allowed of 2 in. on the left and 1 in. on the sides.

This concludes the Elementary Course in Mechanical Drawing.

(See comments on the course under head of Current Topics.)

Read the Want Columns Page 10.

TABLE OF DIMENSIONS FOR BORED GUIDE CROSS HEAD, NO 1

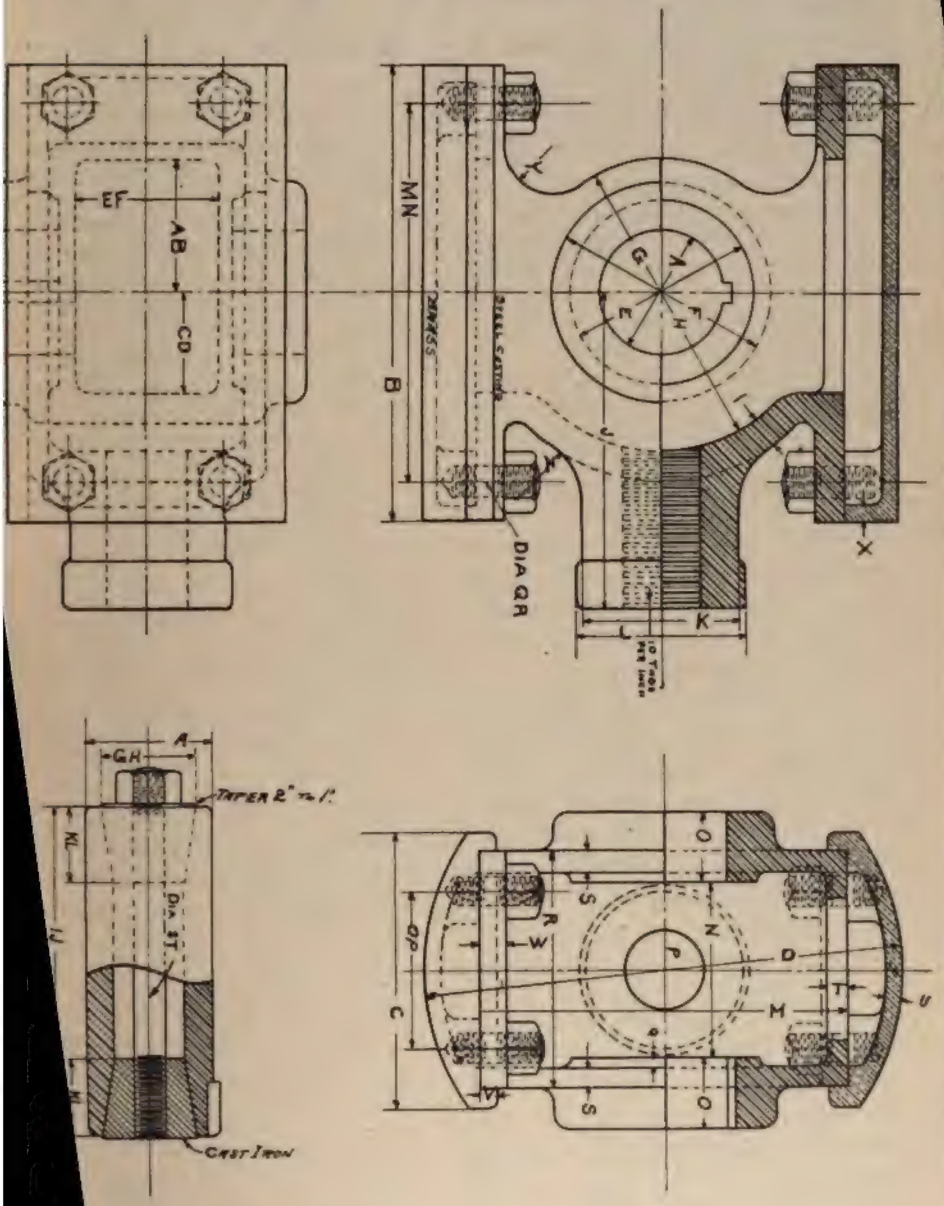
FIGURED FOR A WORKING PRESSURE OF "125"

VALUES OF THE LETTERS

SIZES OF CYLINDERS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
7-8x8	2	7½	4⅜	7½	2⅜	3¼	2⅛	2½	⅝	5	2½	2¾	5¾	2¾	1⅛	1⅛	5/16	3¾
9-10x10	2½	9¼	5½	9¼	3 7/16	4⅜	2⅝	3⅛	¾	6⅛	3⅛	3¼	7⅛	3⅜	1⅜	1⅝	¼	4⅝
11-12-13x12	3	11	6½	11	4½	5⅝	3¼	3⅝	⅞	7⅜	3⅜	4⅛	8⅜	4⅝	1⅝	2	¼	5½
13-14x14	3½	2¾	7½	12¾	5	6	3⅝	4¼	1	8½	4⅜	4⅜	9⅜	4⅞	1⅞	2⅛	¼	6⅜
15-16x16	4	14½	8½	14½	5¾	6⅞	4¼	4⅞	1⅛	9⅝	6	5½	11⅛	6¼	2¼	2⅝	5/16	7¼
17-18x18	4½	16¼	9½	16¼	6 7/16	7⅝	4⅝	5⅜	1¼	10⅜	5⅝	6¼	12⅜	6¼	2¼	3	5/16	9⅝
19-20x20	5	18	10½	18	7⅛	8½	5¾	6	1⅜	12	6¼	6⅞	13¾	7	2¾	3⅜	5/16	9

SIZES OF CYLINDERS	S	T	U	V	W	X	Y	Z	AB	CD	EF	GH	IJ	KL	MN	OP	QR	ST	SIZES OF CYLINDERS
7-8x8	5/16	5/16	¼	¼	7/16	¼	¼	⅜	2	1⅝	2¼	1½	6¼	1⅜	6	2½	½	½	7-8x8
9-10x10	⅜	⅜	5/16	5/16	½	5/16	15/16	1⅛	2½	2	2⅝	1⅞	6⅜	1¾	7½	3	9/16	9/16	9-10x10
11-12-13x12	7/16	7/16	⅜	⅜	⅝	⅜	1⅛	1⅜	3	2⅛	3¼	2¼	7⅝	2⅜	9	3⅞	⅝	⅝	11-12-13x12
13-14x14	½	½	7/16	7/16	¾	7/16	1 5/16	1⅜	3½	2¾	3¾	2⅝	9	2⅜	10½	4⅛	¾	¾	13-14x14
15-16x16	9/16	⅝	½	½	⅞	½	1½	1⅞	4	3¼	4¼	3	10⅜	2¾	12	4⅞	¾	⅞	15-16x16
17-18x18	⅝	11/16	9/16	9/16	1	9/16	1 11/16	2⅛	4½	3⅝	4⅞	3⅜	11¾	3	13½	5⅜	⅞	1	17-18x18
19-20x20	11/16	¾	⅝	⅝	1⅛	⅝	1⅛	2⅜	5	4	6⅜	3⅜	13	3⅜	15	6	1	1⅛	19-20x20

"P" IS TAP SIZE.


EF
AB
CD
MN
B
BRASS
STEEL CASTING
DIA QR
K
L
X
GH
A
TAPER 2" TO 1"
CAST IRON
O
S
N
R
W
D
M
T
C
U
V

CURRENT TOPICS.

Talent For Drawing.

By D. Eldred Wood.

Is it necessary to have a talent or natural ability in order to become an artist or draftsman? Can a person earn a good salary in the field of art without having natural talent?

These two questions have undoubtedly occurred to many persons who are interested in the subject of drawing. They are natural questions to ask, especially when one is considering the advisability of taking up the study of drawing. Many more people would become successful artists if they had not been frightened by the familiar saying of the wise ones (?) that "artists are born, not made." But let us consider the question. Let us see whether it is reasonable to ascribe the success of the well known artists of today so much to nature as to their persistent work and determination.

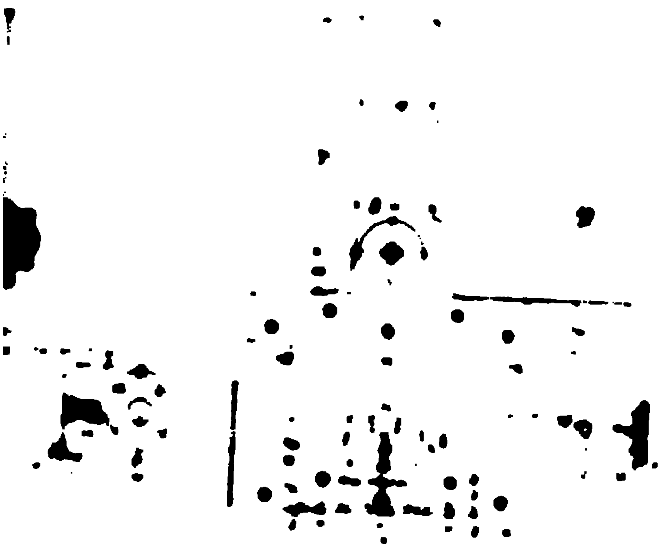
Do you believe that all the lawyers, doctors, ministers, bank presidents, bookkeepers, stenographers, electricians and hundreds of people engaged in the other occupations and professions are born with natural talent and have not acquired any of it? Do you really believe that? Is it not reasonable to say that not more than one out of every hundred is endowed with a few natural qualities which make his occupation or profession particularly easy for him?

Now did you ever see a natural born penman—a person who never studied penmanship and yet could write a beautiful hand? Yes, did you say. Well, ask that person whether he could always write that same beautiful hand, or whether he did not acquire it by conscientious, persistent practice. In nine cases out of ten, he was taught to write just the same as you or I were taught, and after learning the first principles, there was aroused in him a latent faculty which he never knew he possessed, and he continued to practice until one day it came to be known that Mr. so-and-so had become an expert penman of perhaps national reputation. Then people said—after he has *made* his success—"of course he has natural ability."

Do you believe it is true that he had exceptional natural talent? Or rather is it not with the penman as it is with the doctor, lawyer, preacher, the bookkeeper, stenographer, in fact with everybody who achieves success in this world, he has been taught and has learned his profession; beginning with the A, B, C, and working up to the top? In law or medicine one must study and devote years to practice before they can be rated successful, and in the majority of cases, their success is the direct result of persistent study. This is not necessary in taking up the study of drawing.

You would not admit that you could not learn to write for you can write now. Neither would you admit that you could not learn law, medicine, bookkeeping, stenography, or any other subject if you *wanted* to, and liked it. Now, is it reasonable to say that you cannot learn to draw, when you are so deeply interested in it? Why can you not learn to draw and make a suc-

Draftsmans Special Angle



Sketch Pad For Isometric Drawing.

Isometric projection is that kind of representation by lines in which (in opposition to the geometric and polar
2—Draftsman—Fifner 22 22
projection), it is possible, with only one drawing, to represent any object as a solid body, even to one not skilled in the art; and to make on and obtain from such drawing on only one scale, accurate measurements in all three axes of main directions. These three small axes (lying in planes perpendicular to each other), of any isometrically represented object, lie on the flat surface of the drawing at angles of 120°; one of them vertical, the others 30° from the horizontal. No horizontal line of the original appears horizontal on the drawing.

An isometrically drawn cube has as its isometric outline a regular hexagon with three radii 120° apart; a circle lying on one of its faces appears in the drawing as an ellipse with major axis 1.225, minor axis 0.707 times that of the diameter of a circle.

To aid in forming these ellipses outlines are given that can be laid under the sheets.

These outlines aid in rapidly drawing perfectly isometrically projected ellipses in the three principal perpendicularly-lying planes of any object. In all of them the axial ratio is 1 : 3 = 1 : 1.732; that is considering the diameter of any circle as 1,000, the major and minor axes of the corresponding "isometrical" ellipse are 1,225 and 707. Either of ellipses is so laid on the drawing that one of them shall be tangent to the rhombus that represents isometrically the circumscribed about the circle to be projected. The outline is then pricked through with a point of any kind, and the curve afterwards filled in.

Ellipses with a larger major axis may be drawn by any number of ordinates, or approximated by circular curves. Smaller ones sketched in free hand.

Pads of sketch paper are made in 40 sheets each, in sizes, 6 x 9, 9 x 12 and 12 x 18, by The Derry Collard Co., 256 Broadway, New York.

Compendium Of Drawing.

The American School of Correspondence are issuing two volumes on the subjects of mechanical drawing, machine design, sheet metal drafting, shades and shadows, pen and ink rendering, perspective and architectural lettering.

The first two divisions are not altogether new nor made up in any original style but concise and to the point, illustrating the manner of arrangement of the instruction papers of this school.

The chief aim of this work is to acquaint the public with the standard, scope and practical value of these papers through an opportunity for personal examination. Although pub-

[illegible]

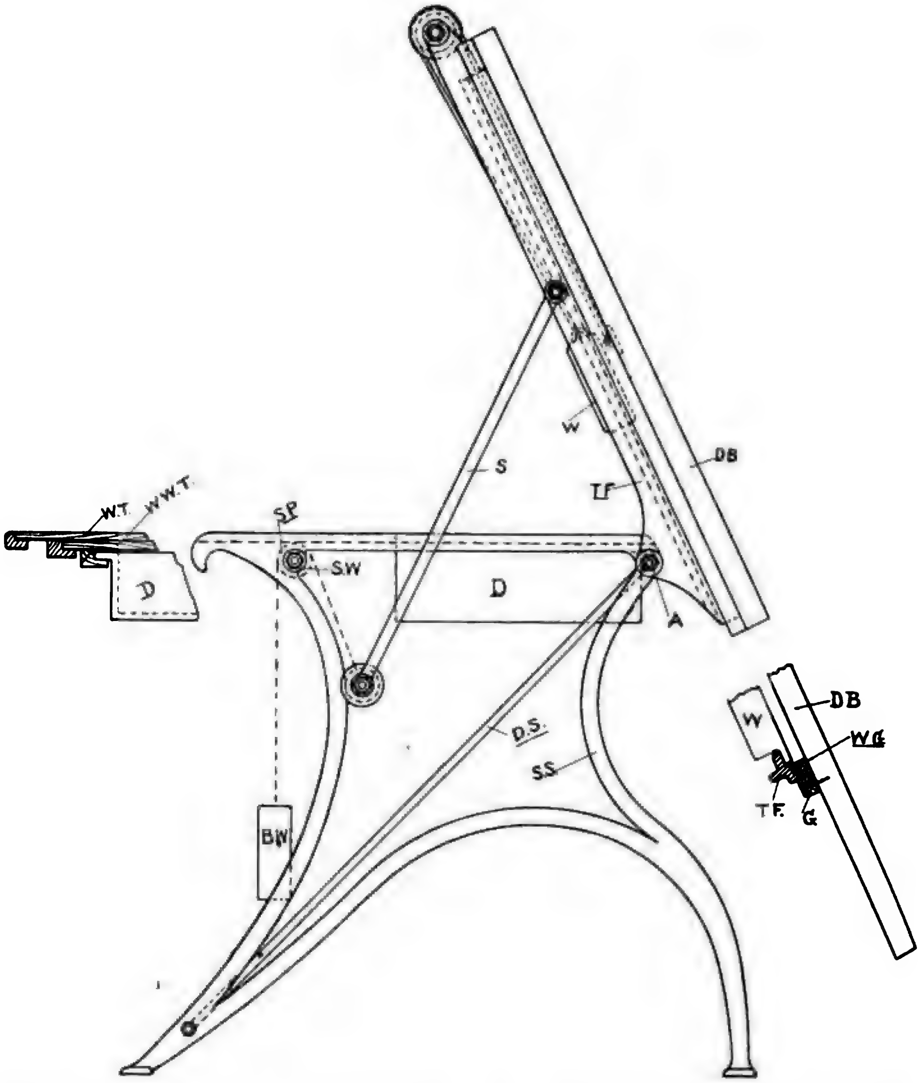
[illegible]

Drawing Table.

R. W. DICKINSON.

I am very sorry that I have not had time to send you the sketch of Drawing Board before now and even as it is, I have only been able to find time to make a very rough sketch (very rough indeed) but trust it will serve its purpose.

Referring to the sketch, it will be seen that it consists of two side stands S. S. which are stayed sideways by a pair of diagonal stays DS. Pivoted to these are at A. are two T. F. These are also shown in Plain Section P. S., fixed to these are wood guides, W. G.



Blue Prints From Typewriting.

Instrument Case.

INSTRUMENT CASE.

The usual mathematical-instrument case, which consists of an under part for receiving the separate instruments (compass, tracing-pencils, and the like) and a cover adapted to fold thereon, is usually of such a width and length that if a large number of such instruments are to be placed therein it is not possible to carry such mathematical instruments in garment-pockets of the usual size.

Now by the present invention a suitable case for receiving a numerous set of mathematical instruments is obtained of a very convenient shape and form, the case being composed of three parts and the separate mathematical instruments arranged therein in two layers.

A mathematical-instrument case of this improved kind is shown in the accompanying drawings.

Figure 1 is an elevation, and Fig. 2 an end view of same.

Fig. I.

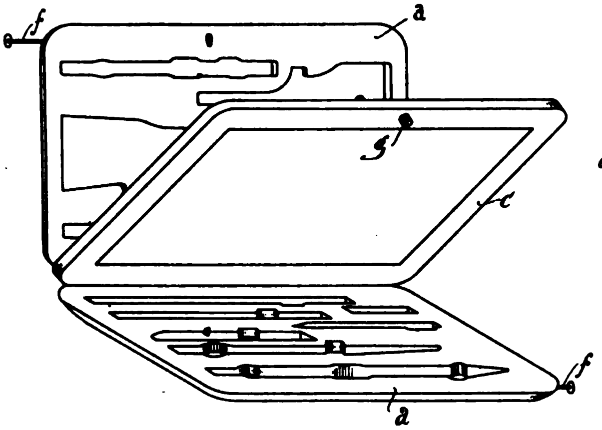
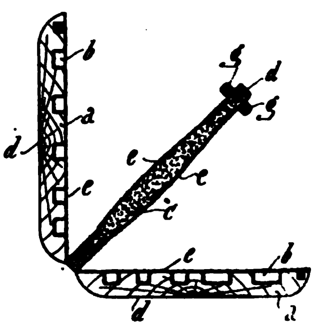


Fig. II.



In consequence of the arrangement hereinbefore described this improved case in spite of its handy shape and its comparatively small dimensions is adapted for receiving a very large number of separate mathematical instruments.

This is manufactured by Georg Schoenner, Nuremberg, Germany.

Engineer Draftsman.

Supervising Architects Office.

The U. S. Civil Service Commissioners holds an examination on Aug. 17, 18, 19 and 20, at the places mentioned on the enclosed list which is with the application blanks, to secure eligibles from which to make certification to fill a vacancy as Engineer Draftsman in Supervising Architects Office at $1,200 per annum and other vacancies as they may occur in that office.

The examination will consist of the

subjects mentioned below:

1. Mathematics (pure mathematics up to and including calculus, theoretical and applied mechanics with special application with the class of work to be done).

2. Materials and design (comprising knowledge in steel, iron, fire proofing, etc. and design of columns, girders, trusses, etc.).

3. Drawing, involving ability to draw designs neatly to scale, tracings, etc.

4. Educational training and experience.

Time alloted for examination, first day 5 hours, second day 7 hours, third day 7 hours.

Age limit 20 years and over.

Competitors should bring with them drawing board, not less than 15" square, scale, drawing instruments, pencils, etc., and if you so desire slide rule.

This examination is open to all citizens of the U. S. if they comply with the conditions.

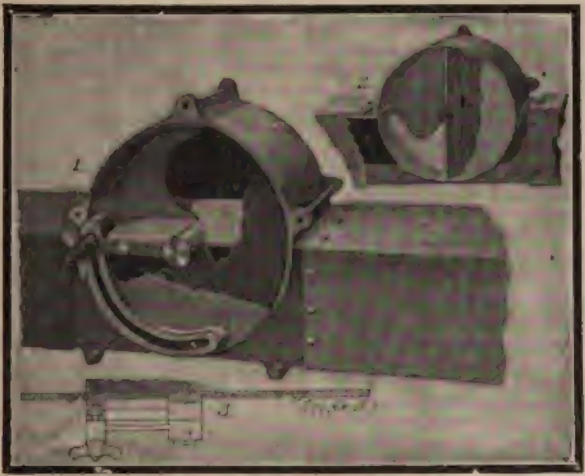
Applicants will apply to the U. S. Civil Service at Washington, D. C.

A Grain Valve Cut Off.

In past years there has never been a satisfactory valve or cut off for grain or similar substances.

Mr. Geo. J. Noth, of Davenport, Iowa, has recently perfected a valve opened or closed as with other styles.

It can be set at any desired opening without further attention and is easily attached and detached and less expensive in construction than other valves.



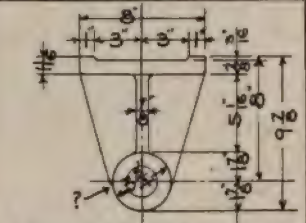
that has none of the faults of the others and many features to commend itself.

With it there is absolutely no leakage, whether it be ground corn or nut hard coal, when it is closed, *it is closed*. Then there is no crushing, mashing or shearing of grain, when

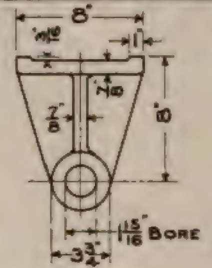
It is the result of many years investigation and study to obviate the faults and perfect the existing styles.

As seen in the illustration, the valve rotates clear of the passage offering no resistance to the flow of the material and the locking mechanism is clearly defined.

COMMON ERRORS IN MECHANICAL DRAWING.



SUPERFLUOUS DIMENSIONS POORLY DISPOSED, IMPORTANT ONE OMITTED, NO DISTINCTION IN WEIGHT OF LINES.



PROPERLY DIMENSIONED. CLEAR DISTINCTION.

SIDE VIEW OMITTED.

A BAD LINE.

A GOOD LINE.

WEAKENED BY ERASURE.

A BAD DOTTED LINE

AN AVERAGE ONE

WHICH LINE DOES THE ARROW MEAN?

EITHER WAY O.K.

LETTERING LIKE THIS TAKES UP TOO MUCH VERTICAL SPACE.—

Be Careful About Extra Tails On Letters

LETTERING LIKE THIS TOO SMALL AND CROWDED TO SHOW UP WELL. LINES NOT CONNECTED

THIS IS A HURRY UP JOB WITH THE RULING PEN.

Round Writing too Fancy.

Used more in structural than machine work.

PERHAPS THIS DESIGN IS BETTER LIKED.

DON'T SAVE INK. MAKE IT SO IT WILL PRINT WELL.

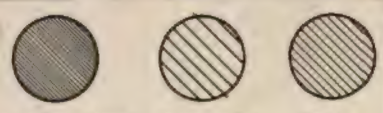
Dont Mix Styles of Painting. FORGOT HE STARTED VERTICAL.

Shading Adds Nothing.

TWO WAYS OF SAYING THE SAME THING.

DRILL AND TAP FOR $\frac{3}{4}$" GAS PIPE. BETTER SAY, $\frac{3}{4}$" PIPE TAP.
$\frac{3}{4}$" CORED HOLES. BETTER SAY, $\frac{3}{4}$" CORE. 6" DIA. BORED. SAY, 6" BORE.

ONE RIGHT HAND, MARK B20.
" LEFT " , " B21.
RIGHT HAND ONE IS SHOWN.
BETTER SAY
1 AS SHOWN. B20.
1 OPP HAND. B21.



WASTE OF TIME. SLOPPY FAIR.

MAKE WORKING DRAWINGS FOR THE WORKMAN. IF PICTURE DRAWINGS ARE REQUIRED HIRE AN ARTIST.

MAKE TITLES COMPLETE BUT VERY CONCISE. DON'T DRAW BOLTS UNLESS THEY ARE SPECIAL. LIFE'S TOO SHORT TO SHOW NUTS IN PLAN.
C.I. = CAST IRON. W.I. = WROUGHT IRON. MAL. I. = MALLEABLE IRON. S.C. = STEEL CASTING. C.R.S. = COLD ROLLED STEEL. MED. ST. = MEDIUM STEEL. ST. = MILD STEEL. T.S. = TOOL STEEL. L.G.T.S. = LOW GRADE TOOL STEEL. M.S. = MACHINERY STEEL. BZ. = BRONZE.

J.S. MYERS. 13MY04.
1025 WALNUT, PHILA.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study

PUBLISHED MONTHLY AT CLEVELAND, OHIO

SCROLL DRAWING.

Very often a little ornament in the way of a simple scroll will add to the appearance of a piece of work and therefore a few directions may be appreciated.

Fig. 1 shows a very simple scroll easy of construction. To lay this off,

Fig. 1

Fig. 2

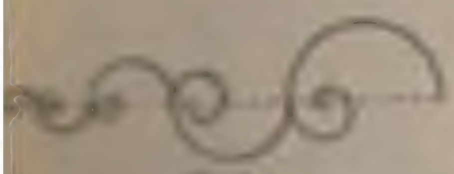


Fig. 3

draw a straight line and set off a number of equal distances; then with a radius equal to one of these distances, using as centers every other point, draw semicircles on alternate sides of the straight line.

Fig. 2 shows a tapering scroll. To lay this off, set off on the straight line a series of two equal spaces, each two spaces being smaller than the preceding one; then draw semicircles, as in Fig. 1.

Other portions of circles may be drawn from any part of the scroll, especially at the junctions of the semicircles, as shown in Fig. 3.

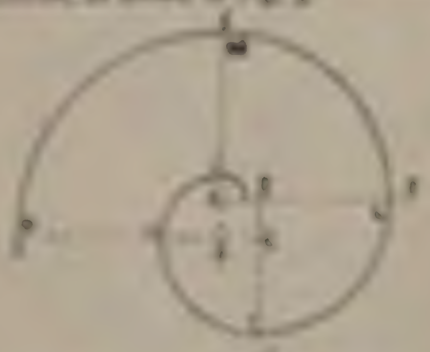


Fig. 4

In Fig. 4, we give a method of drawing a figure resembling a spiral by arcs of circles. First draw a small square A B C D, and extend each of its sides, as shown, to the points E F G H. With the compass set to a small radius draw a quarter circle from the point A as a center, commencing at the line AF and ending with the line D E.

From the point D as a center, draw

the arc I J with a radius D I. In a like manner draw arcs, using successively the points C, B, A and D, the raduis for each arc being greater

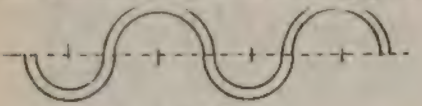


Fig. 5.

Fig. 6

than the previous one.

If desired the spiral may be commenced at the outside, drawing the successive arcs with a shorter radius than the previous one.

After the outline of scroll is drawn,

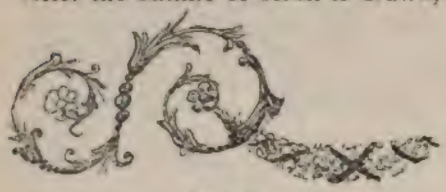


Fig. 7.

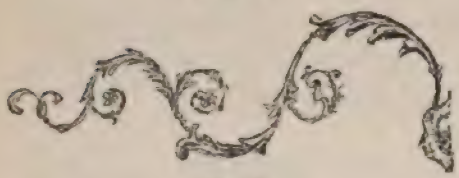


Fig. 8.

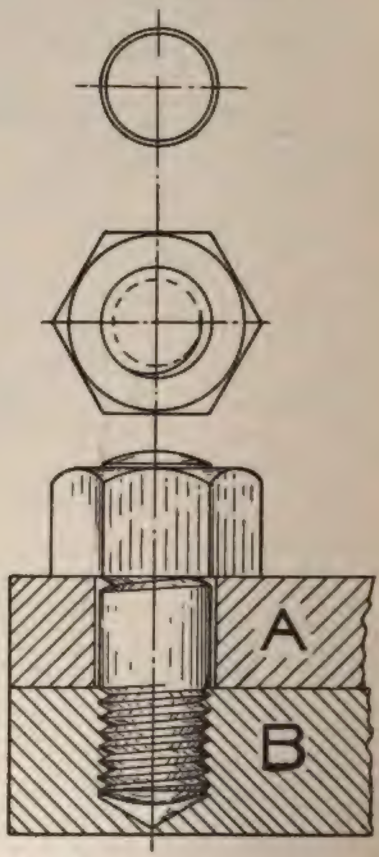
it may be elaborated upon to suit one's own taste. The method of getting centers for a double scroll is shown in Fig. 5. Figs 6. 7 and 8 show various ornamented scrolls which will serve as hints. Fig. 6 is after Fig. 5. Fig. 7 is an application of the spiral in Fig. 4, and Fig 8 is an elaboration of Figs. 2 and 3.

"Self Education."

Crude oil's economy in at least one direction over coal as a fuel is demonstrated in the run of a steamer from San Francisco to New York, in which three furnace men did the work requiring twelve stokers when coal was used.

Lettering is the title of a book by C. E. Sherman, a complete treatise on the subject stated. This edition of the book is bound in red cloth covered board covers, the body matter well printed and illustrated, there being several additions to the old text. The book is well suited for schools, in fact was originally designed for that purpose, but would be a fine addition to any draftsman's table. Postpaid $1.00. The Midland Publishing Co., Columbus, O.

England makes but a third of the the remainder $1,308.00 worth of it comes from America and $212,000 from Canada.

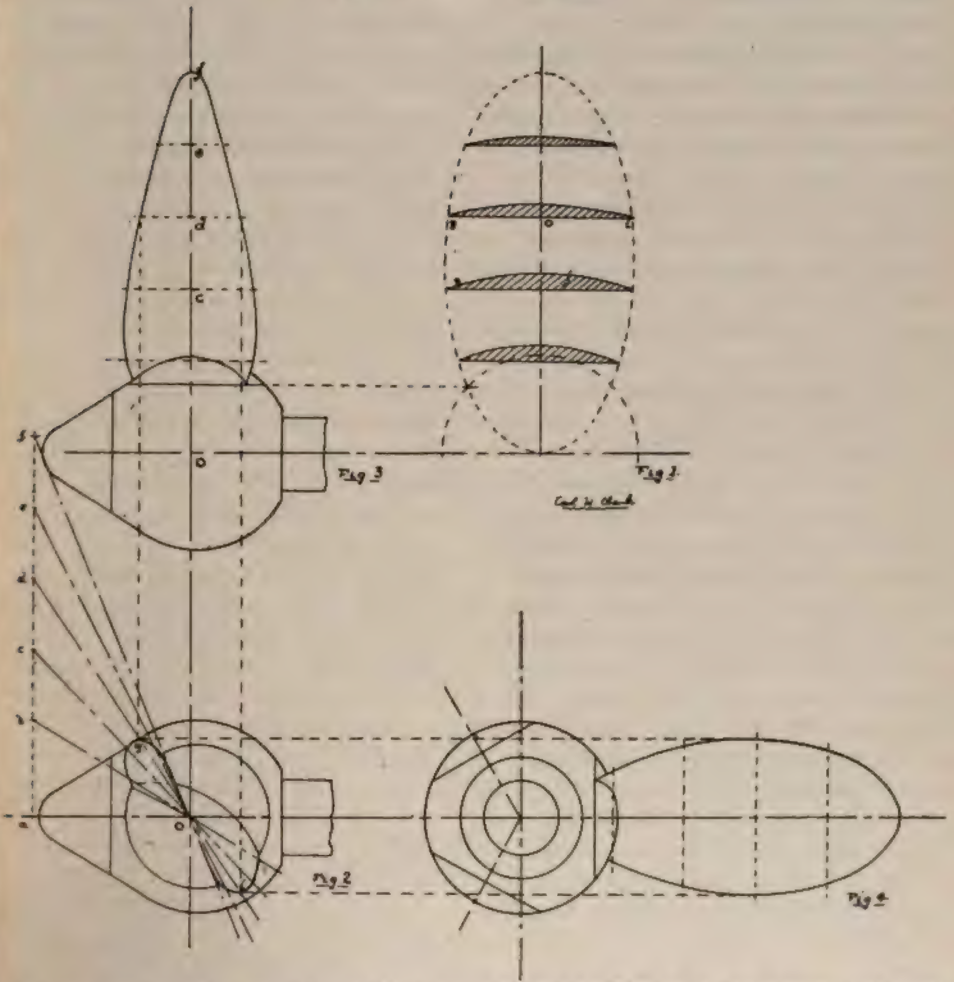


How to show a stud and nut and also a top view of the tapped hole.

MECHANICAL.

The Design of Screw Propellers.

By CARL H. CLARK.



In our last article on this subject we gave directions for determining the diameter, pitch, and blade area for any given circumstances, and it is the object of the present article to describe the process of making the working drawing of the propeller. Referring to the cut, Fig. 1 is the expanded outline of the blade, or the approximate shape which the blade would have if, instead of being twisted, it were a plane; it is eivdent that this is only approximately possible. Fig. 2 is the end view of the blade, looking directly down upon it;

the gradual twist is readily noted. Fig. 3 is the side, or athwartships view, and Fig. 4 is the rear, or fore and aft view.

Starting now with the expanded outline, this is usually of approximately elliptical shape and of the proper area to give the required blade area. For tow-boats and similar work where a large area is required the outline may be filled out at the tip; its usual width is from 4-10 to 5-10 of the radius. It should be borne in mind that the elliptical form is not necessary, but is a very convenient starting point. Allowance must be made for the hub in figuring the area.

Referring to Fig. 2 the distance o a, is laid off to the same scale as the drawing, and equal to the pitch in feet divided by 6.283; at "a" the perpendicular "af" is drawn, and the distance "af" made equal to the length of blade, or half diameter of propeller. The equal space "ef," "de," "cd," etc., are next laid off, and through the center O the lines "of," "oe," "od," etc., are drawn, which give the angles of the blade at each point. It is also to be noted that the breadths of the blade at all points are shown in their true size in this plan, so that these breadths will be the same as those in the expanded blade for corresponding points. The distances "ef," "de," etc., should be laid off on the axis of the expanded blade and horizontal lines, like "gi" drawn across the contour. The breadths in Fig. 1 "og," "oi" are now to be laid off in Fig. 2 from the center, as "og"-"oi." Each breadth from Fig. 1 is laid off thus in Fig. 2 on the corresponding pitch line, enough points being taken to define the blade outline, and new pitch lines being drawn if points are desired between those already drawn; the outline is then drawn in through these points.

To obtain the side elevation, Fig. 3, the distances "ef," "de," etc., are laid off as before; the intersections on Fig. 2 are then projected directly on to these lines. The fore-shortening effect of the changing angle of the pitch lines is shown in the pointed appearance of the blade. The fore and aft view Fig. 4 is obtained in a similar manner, by projecting horizontally, giving the outline as shown.

The hub in this case is spherical, with a conical cap. The blade outline is carried in until it intersects the spherical hub, the distance of this point from the center being determined by drawing the circle of the hub diameter on the expanded outline and projecting the intersection across, as shown. It is to be noted that in both Fig. 3 and Fig. 4, one edge of the blade appears in front of the hub, while the other disappears behind it. The projections shown are for a right hand propeller; if a left handed one were desired, the line "af" and the other spaces would be laid off below the center line, thus inclining the pitch lines in the opposite direction.

It is a very common thing to have the axis of the blade "of," Fig. 3, slope aft, instead of being perpendicular, in which case the line "af" in Fig. 2 will slope at the same angle, and the pitch angle lines, instead of all intersecting at O, will each be set back by the amount which the points "c," "d," "e" are back from the vertical; in other words these pitch angles will be the same as already described, but will be set back the distance that "c,d,e" are from the vertical.

The above description is for a blade, the pitch of which is constant throughout; in case the pitch varies, as is often the case, the points "c,d,e" will not all be on the same vertical, but each will be on its own vertical line drawn at a distance from O equal to pitch divided by 6.283, the pitch used being that at the several points "c,d,e."

The projectors described are those of

the working surface of the blade, the thickness to give strength being put on the back. The section at several points is shown by the sections on Fig. 1, these are nearly segments of circles, the thickness of the blade tapering from root to tip. It will be noticed in Fig. 2 that the center line of the surface is not at the center of the hub; this is because of the thickness of the blade, which is put on the back, thus bringing the center of the body of the blade about over the center of the hub.

The propeller illustrated has three blades, which are detachable; this accounts for the rather large hub, as it must be large enough to accommodate the flanges of the blades, which are set into the hub with a taper, and secured with bolts. The conical cap on the after end is put on to allow a free passage of the water and avoid eddies. When the propeller is cast solid, the hub can, of course, be made much smaller, it being only necessary to have sufficient metal to give strength around the shaft.

The various details of varying pitch, shape of blade, and design of hub, can only be dealt with generally in an article of limited length, as they are to a great extent governed by the experience and preferences of the individual draftsman or engineer. For a more detailed discussion of these matters the reader is referred to the various books and publications on this subject.

MINE VENTILATION.

Charles Kuderer, chief engineer of the mechanical department at the Monongahela Manufacturing company's plant, has made the following tests on his patent force or exhaust steel mine ventilator:

DIAMETER 6'—0" WIDTH 3'—0"

Revolutions per minute	300	400
Volume cubic ft. per minute	56,190	76,150
Pressure inches W. G.	6-10	1.
Ventilating pressure lbs. per sq. ft.	3.12	5.2
Work ft.. lbs. in air	175,230	396,000
Horse power in air	5-31	12
Volume cu. ft. free air per minute	....	....

The ventilator tested has two inlets 3 feet 6 inches in diameter. The test showed 78 per cent. efficiency at 300 revolutions per minute. This is more than was expected and is entirely satisfactory to the company.

This ventilator is the invention of Charles Kuderer, and the Monongahela Manufacturing company have the exclusive rights to manufacture them.

The company expects to have large of their high efficiency in handling large sales of the new ventilators on account volumes of air. They are built of cast metal sections inclosed with steel plates, the whole forming a light and thoroughly substantial air-tight structure, and is also fire proof.

The ventilators will be made on the duplicate, interchangeable part system and in sizes from four to twenty-five feet in diameter. They are known as the Centrifugal, such as take air in the center or inlets passing through the wheel and discharging from the ends of the blades. Mr. Kuderer has the assurance of Thomas M. Evans, treasurer of the company, that if the sales warrant, the size of the plant here will be increased. These fans if properly cared for will last at least twenty years.

The inventor, Charles Kuderer, is a native of Elizabeth, New Jersey, and has been here for more than two years. He received his education at the International Correspondent School at Scranton, and has worked as draftsman in some of the best engine and machine works in New York and New Jersey.

Mr. Kuderer has other patents on ventilators pending at the present time, which when patented will be valuable additions to mine equipments.

The Four-cycle Engine.

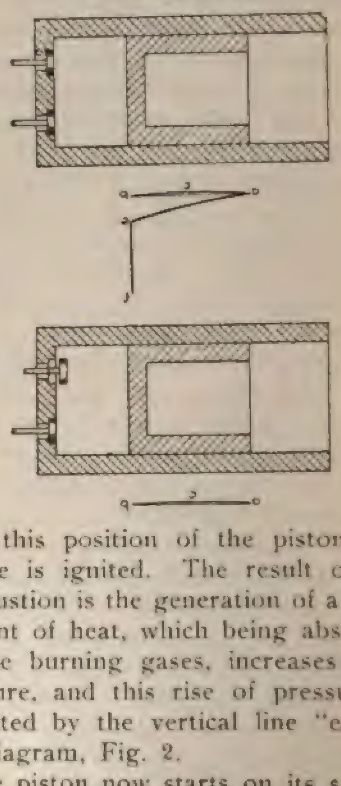
By Mr. R. T. Strohm.

The four-cycle type of internal combustion engine differs from the two-cycle in the fact that it requires four successive strokes to complete a single series of operations, while the latter requires but two strokes to complete the same round of events. In each case the same order of events is observed. First, taking in of the charge of inflammable gas; second, compression of this charge; third, explosion and subsequent expansion; and fourth, exhausting of the burnt gases.

Let us follow out the action of the four-cycle engine by means of sectional illustrations and indicator diagrams, both of which will make clear the sequence of the various events as nothing else might do. In Fig. 1 is shown a sectional view of the cylinder, with the piston at the head end of its stroke, ready to fill the cylinder with its explosive charge. With the starting of the piston toward the right, on its first forward stroke, the fuel inlet valve opens, and permits the combustible gas to enter the cylinder. If this gas flowed into the cylinder fast enough to follow up the advancing piston and fill the space made by its advance, the indicator pencil would trace a straight line as the indication of the suction stroke. But owing to the fact that the piston moves slowly at the beginning of its stroke, increasing in velocity until the middle of the stroke is reached, and then again decreasing in velocity toward the opposite end of the stroke, the pressure in the cylinder varies somewhat, and frequently there is a partial vacuum in the cylinder during the suction stroke. This is greatest at the moment when the piston is moving most rapidly, or near the middle of the stroke, and hence the suction line becomes a curved line "bca" lying slightly below the line of atmospheric pressure.

Having reached the outer dead centre position, the piston now returns, on its first backward stroke. Simultaneously with its reverse in direction of movement, the fuel valve closes. The combustible charge is thus encased in a closed chamber whose volume is being rapidly decreased by the return of the piston. The result of this compression is to increase the pressure of the gases, and this rise of pressure is manifested on the indicator diagram by the line "ae" in Fig. 2, rising gradually from the beginning of the return stroke. Thus, when the crank has completed its first revolution, the piston is in its first position, as shown in Fig. 1, but the compression chamber contains a volume of gas at high pressure.

FIGS. 1 and 2.

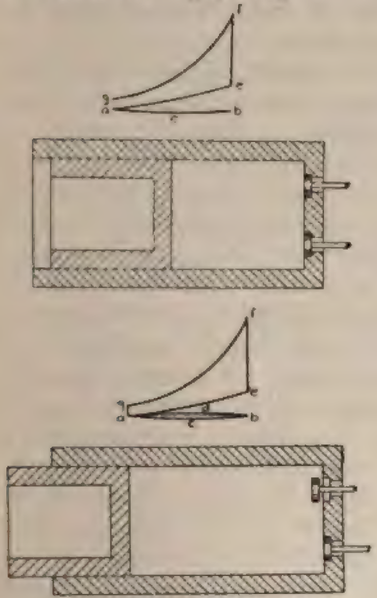


At this position of the piston, the charge is ignited. The result of the combustion is the generation of a large amount of heat, which being absorbed by the burning gases, increases their pressure, and this rise of pressure is indicated by the vertical line "ef" on the diagram, Fig. 2.

The piston now starts on its second forward stroke, being impelled by the

pressure of the gases. This movement increases the volume of the gases, and hence their pressure falls, as indicated by the line "fg," Fig. 3, until the end of the stroke is reached. This is called the expansion stroke or working stroke, since it is the stroke during which the engine is doing work received from the heat energy of the fuel. The corresponding diagram line is called the expansion line.

Upon reaching the end of its second forward stroke, the piston has moved as far to the right as it can go, and the greatest possible expansion of the gases has been utilized. Hence, at this juncture the exhaust valve opens, and the burned products are allowed to escape from the cylinder. The drop of pressure at the end of the stroke is represented on the diagram by the short vertical line "ga," Fig. 4.



FIGS. 3 and 4.

There remains now but one more operation to complete the cycle and return all parts to the same condition as at the beginning of the first forward stroke. This last operation is the second return stroke of the piston, by which the gases are expelled from the cylinder, as shown by the line "adb," Fig. 4. The conclusion of this second backward stroke brings the piston to the head end of the cylinder, as in Fig. 1. The exhaust valve closes, and the inlet valve opens, and the engine is in condition to repeat the cycle just mentioned.

In the actual engine, however, there are a number of modifying conditions which prevent the attainment of the form of indicator diagram such as that shown in Fig. 4. A representative card from a four-cycle engine is shown in Fig. 5. The line "ab" represents the line of atmospheric pressure. On the suction stroke, the pressure in the cylinder falls somewhat below that of the atmosphere, and consequently the suction line "bca" falls below the atmospheric line. On the return stroke, the compression line "ae" is formed. It will be noticed that the point "e" does not lie at the end of the diagram, but rather at a point just before the end of the stroke is reached. Explosion begins at this point, as evidenced by the rapid rise in the curve from "e." In other words, ignition takes place before the piston reaches the end of its stroke. This is one marked difference between the actual and the theoretical diagram. It will be seen that in the card on Fig. 4, the ignition takes place exactly at the end of the stroke giving a vertical explosion line. It is not practicable to have the ignition occur when the engine is on dead centre because it requires a certain short interval for combustion to be completed. Hence to realize the maximum explosion pressure at the beginning of the second forward stroke, ignition is made to occur slightly in advance of the dead centre position. The expansion line is "fg," release occurring at the point "g," instead of at the end of the stroke, as in Fig. 4, this being another particular in which the actual and the theoretical cards differ,

since the fall of pressure cannot occur instantaneously upon opening the exhaust port. The expulsion of the waste gases takes place along the line "adb," which rises slightly above "ab" owing to the resistance to the passage of the gases through the port.

There is much rivalry between the builders of two-cycle engines and the builders of four-cycle engines, and since each type has given satisfaction in operation, each has its hosts of partisans. It may not be amiss, therefore, to compare the two with a view to observing their relative merits.

In the first place, the two-cycle engine has an impulse every revolution, while the four-cycle cannot have more than one power stroke in each two revolutions. As a result, the former would give a much more uniform turning effort than the latter, if each had the same weight of flywheel. But, the function of the flywheel is to equalize the turning effort. By it, energy is stored up when the effort of the engine is much greater than the resistance, and again given out during such portions of the stroke as the resistance is greater than the crank effort. Hence, by increasing the weight of the flywheel in the four-cycle type, it can be made to run as uniformly as the two-cycle engine. But the heavier flywheel makes the four-cycle engine much exceed in weight the two-cycle engine of equal power.

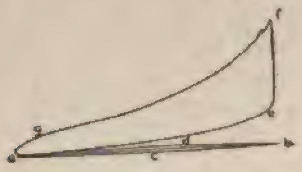


FIG. 5.

On account of the greater frequency of recurring of power strokes, the two-cycle engine is lighter, per unit of power developed, than the four-cycle engine. This makes it of value as the motive power for light vehicles, such as motor bicycles and tricycles, and especially valuable for airship propulsion. It is also a high-speed engine, being capable of making 2500 revolutions per minute, and being so, the force exerted upon the piston need not be as great as in a four-cycle engine of equal power. In other words, the parts of the two-cycle engine may be made much lighter than those of the four-cycle developing the same power.

But the four-cycle engine is by far the most widely used in automobile construction at the present time, and hence we may expect to find that it possesses advantages over the two-cycle engine which especially fit it for automobile work. Inasmuch as the explosions occur every other revolution, there is a short period in which the cylinder walls may cool down from the temperature to which the combustion has raised them. In the two-cycle engine the explosions follow each so closely that the cylinder becomes extremely hot, and this frequently leads to trouble. For if any portion of the cylinder walls or piston should become hot enough to fire the incoming charge, premature ignition would result, with consequent loss of power. With the two-cycle motor, the charge is compressed in the crank case before admission to the cylinder, and the governing is effected by throttling the exhaust. In case the engine is running under variable load, and the inlet port should open before the combustion is completed in the cylinder, the result is that the flame will run back and ignite the mixture in the crank chamber, and unless this mixture is promptly renewed the engine may slow up or stop altogether. The two-cycle engine has been particularly successful in driving launches simply because of the uniformity of the resistance.

The increased weight of flywheel of a four-cycle engine need not necessarily

Shafting, Turned And Rolled.

Some questions came up not long ago on the subject of shafting.

1st. Could a buyer get shafting with diameters in sixteenths, that is, 1 3-16, 1 5-16, or 2 7-16, etc., or would he have to order a 1-16 larger.

2nd. What were the standard lengths?

3rd. Advantages or disadvantages of turned, cold rolled and cold drawn.

Answers came from the following, which may be of interest to our readers.

(From Pittsburg Steel Shafting Co.)

Turned shafting is superior to shafting produced by either the cold rolled or cold drawn processes for the reason that by this process the surface of the metal is not laminated, and the bar is not subject to internal strains that cause crystalization and liability to fracture.

Cold rolling or cold drawing, especially where work is done too rapidly, will often so distort the structure of the steel that a bar will often break in pieces like glass when dropped on the floor. This will seem strange to those who have not actually seen such a thing. Such distortion of the metal is not possible in a turned shaft. In a cold rolled or cold drawn shaft there always exists an internal strain. This is proven by the fact that if a cold drawn or cold rolled shaft is keyseated on the surface, cut through for any purpose, the bar will spring out straight and will twist on its axis. This bar must be straightened again before it can be used. This twisting and bending after keyseating will not occur in a turned shaft, as there is no internal strain existing therein. By the old method of turning shafting in a lathe, with the bar revolving between centres, it was almost impossible to get the shaft perfectly round or parallel, owing to the wear and tear of tools, etc., and even by the use of a file it was not possible to make it perfectly true.

With our patent machines, however, it is possible to turn a perfectly round and parallel shaft to any diameter desired. After being turned our shafts are passed through smoothing and polishing rolls, which gives them a very high finish. After being cut to required lengths and carefully inspected for laps, seams, slivers and such defects in the surface of the steel, the shafts are put on testing rolls, on which they revolve; thus it is easily possible to determine whether or not the shafts are straight.

The shafts are carefully straightened until they revolve perfectly true on the rolls, when they are ready for shipment.

We therefore claim for shafting of our manufacture the following advantages:

1st. There are no existing internal strains, due to the process of manufacturing. This is especially desirable where strength is required, as it is frequently the means of preventing serious accidents, loss of time, money and life.

2nd. It has such a smooth and highly polished surface as to be attractive in appearance and especially adapted for use as piston rods.

3rd. Being carefully true to size, couplings, pulleys, etc., can be more satisfactorily and easily fitted to the shafts.

4th. Being perfectly round and straight it can be run at a very high speed without vibration or heating of journals.

(From the Jeffrey Manufacturing Co., Columbus, O.:)

"Replying to your favor of the 30th ult., will state that our information concerning cold rolled shafting only applies to those sizes and uses which appertain to our business. We, of course, use large quantities of cold rolled shafting.

ranging in size from 15-16 of an inch to 4 15-16 inch. If a firm were to order cold rolled shafting 2 1-2-in. in diameter, it would receive exactly that size, and not 2 7-16-in. Both sizes are made, but in common practice it has come to be the rule that the variations of sixteenths of an inch have been accepted as standard. However, it is still possible to get shafting 2 1-4 and 2 1-2 or 2 3-4 of an inch, but these diameters are not used extensively.

"We still find some people, more particularly in the South and in the New England States who order 2 1-2-in., 2 1-4-in. or 2 3-4-in. shafting. We presume that this is because they are repairing old machinery which was put in years ago when these sizes were more commonly used.

"In one line of work we still use the 2 1-2 and 3-in. shafts, viz.: in spiral conveyers. There is considerable of this size used for bearings in spiral conveyers on account of the fact that the conveyer is mounted on pipe of such interior dimensions that these sizes are best adapted to the use.

As to the lengths which are carried in stock by dealers, we find, generally, that dealers have lengths of 6, 8, 10, 12, 14, 16, 18 and 20 feet; they are not apt to carry anything above 20 feet, although we have found some dealers who do carry some pieces of 22 and 24 feet lengths; but ordinarily it is necessary to have the mills get out these longer lengths especially for the work."

(From Jones & Laughlins, Pittsburg:)

"We have your favor of the 30th, ultimo, asking for information in regard to cold rolled and other styles of shafting, and stating that the question has come up whether in ordering shafting 2 1-2-in., it would be 2 1-2-in. or 2 7-16-in.

"We would say in reply, that, in our practice, we always send the size of shafting that the customer asks for. In other words, if they specify 2 1-2-in. shafting they get 2 1-2-in., not 2 7-16-in.

"In regard to the lengths that we carry in stock, would say that we usually have on hand lengths running from 12 feet up to 24 feet. Standard lengths, as a rule, are 16 to 20 feet. All the shafting that we manufacture is cold rolled, the process of manufacture of which puts a polish on same."

Determining The Weight of Castings.

By C. M. Schwerin.

The instrument known as the Polar Planimeter was invented by Professor Andler in 1856, and is used to determine

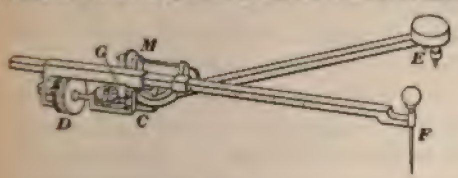


FIG. 1.

areas of irregular flat surfaces. As shown in Fig. 1, it consists essentially of three parts, the carriage revolving on measuring wheel D, the pole arm, to which is affixed the pole E, and the tracing arm, which carries the tracing point F. M is a screw adjustment for accurately setting the carriage which slides along the tracer arm. G is a recording dial, connected by the worm on the carriage with the measuring wheel D, which records the number of complete revolutions made by the wheel.

The area of any plane figure, no matter how irregular in outline, may be obtained by pressing the point of pole E into the paper and then tracing the outline of the figure with the tracer point

F. The complete outline must be gone around, and the tracer must return to the point from which it started. The wheel D will show the area.

The instrument can be set so as to read in square inches, square millimeters or fractions of any unit. All area instruments are made in various sizes, but the one with the 12-in. radius is the one most convenient for ordinary use.

The above instrument has been satisfactorily used for obtaining areas from maps drawn to scale and for obtaining area of indicator diagrams in making engine tests.

A particular use to which the foundrymen may put it, is to obtain the weight of a casting from the drawing of the pattern or of the casting itself, when the casting cannot be divided into regular geometric figures.

The following is an example of the calculation for two car wheel patterns.

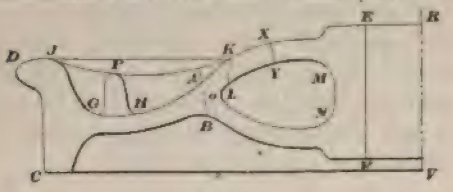


FIG. 2.

A car wheel pattern presents almost as complex a problem as it would be possible to have, so that the general idea here brought out could be modified to meet any class of work.

The object of this graphic method is to estimate the weight of the casting, which is to be made from a given pattern, when the cross-section is not a uniform geometrical figure. Such an estimate is a very important guide to the foundryman, who would otherwise guess at the probable weight of a casting of new design, and, in trying to be on the safe side, would probably melt an unnecessary amount of iron. It is also an aid to the designer of a new car-wheel pattern, who must otherwise from general experience determine the probable weight, have test wheels made, and correct the pattern afterwards, so as to obtain the weight prescribed.

For the method here described, an accurate drawing of the pattern is employed. This gives a closer result than a drawing of a wheel itself, for the following reasons:

1st. Calculations based upon the actual dimensions of the wheel involve the erroneous assumption that the specific gravity of the casting is uniform throughout; and upon that basis the calculated weight would be wrong because the amount of metal poured has shrunk in the mould, acquiring the highest density in the outside chilled portion, and growing less dense through the mottled to the gray portions.

2nd. Calculations based upon the dimensions of the pattern or "chiller" assume that the cooled metal will not have shrunk but will have the volume of the pattern and a uniform density.

These assumptions, though erroneous, counterbalance each other. For instance, the pattern and the chiller, which will give a wheel of 33-in. diameter when cold, are respectively 33.5-in. in diameter. This shows a shrinkage of wheel iron of about 3-16-in. per ft.

Ordinary gray iron is assumed to shrink 1-8-in. Wheels cast in 33.5-in. chillers do not always have the same diameter. They may vary 1-8-in. either way by reason of differences in composition, pouring temperature, duration of pouring, and also probably slight variations in cooling. But the average diameter is 33-in.; and it is found that a calculation based upon the 33.5 pattern, and the assumed uniform density of 0.26 lb. per cub. in. of molten wheel iron, as it fills the mould, gives correct weights of the wheels, even though the latter vary in size, as before explained.

For a casting of uniform specific gravity either the drawing of the cast-

ing, or that of the pattern, could be used. If the latter, then a percentage for shrinkage must be subtracted.

Fig. 2 shows, in reduced size, half the cross section of the pattern of an ordinary cast-iron car wheel.

From the full-sized drawing, divided by the line A B, as shown in the figure, the areas A, B, C, D, and E, F, B, A, are taken with the planimeter, and the areas L, M, N, similarly determined, are subtracted from their sum. The remainder is the area of the half-section of the pattern, exclusive of the brackets. Let this area (in sq. in.) be called A. The reason for dividing the drawing by the line A B, is because the planimeter was not large enough to measure the whole area.

The following calculation for two wheels is given as an example:

The calculation for $2 \times 3.1416 \times R \times A \times w$ was as follows:

	No. 1.	No. 2.
Area of E. F. C. D	52.38 sq. in.	53.17 sq. in.
Area, L. M. N.	12.42 sq. in.	9.60 sq. in.
Net area (A)	39.96 sq. in.	43.57 sq. in.
R	9.38 in.	9.25 in.
Cubic contents of pattern	2353.6 cu. in	2531 cub.in.
Weight (cub. cont. x 0.26	611.95 lbs.	658 lbs.

The requisite addition for weight of brackets is approximately calculated as follows:

	No. 1.	No. 2.
Area G. P. H	2.24 sq. in.	2.30 sq. in.
Assumed average, ½ G. P. H.	1.12 sq. in.	1.15 sq. in.
Arc length measured on curve	10.5 in.	10.25 in.
Volume of one bracket	11.8 cub. in.	11.8 cub. in.
Weight (vol. x 0.26	3.06 lbs.	3.06 lbs.
Weight of 13 brackets	39.78 lbs.	
Weight of 15 brackets		45.9 lbs.

NOTE: The 650-lb. wheels have 13, and the 700-lb. wheels 15 brackets.

The weights of the letters was obtained by weighing the same letters cast in lead, and taking seven-tenths of the result as correct for iron. This gave, for each wheel, 1.2 lbs.

The amount to be subtracted for the metal displaced by the core-legs was calculated as follows:

	No. 1.	No. 2.
Thickness (x y) of bottom plate	[illegible] in.	1 3/16 in.
Approx. av. diam. of core legs.	2⅜ in.	2⅝ in.
Area of base of equiv. cylinder	4.4 sq. in.	5.9 sq. in.
Volume of equiv. cylinder	4 cb. in.	6.5 cub. in.
Weight (x 0.26) for one core leg	1 lb.	1.7 lbs.

The final net weight for each wheel was determined as follows:

No. 1 ..611.95 + 39.78 + 1.2 — 3 = 649.93 lbs.

No. 2 ..658 + 45.9 + 1.2 — 5.1 = 700.00 lbs.

A blue print is then made, pasted on cardboard, cut out along the lines D, E, F, C, D, and L, M, N, L, and then balanced on a pinpoint, to determine the center of gravity of the irregular figure. This point (O in Fig. 2) is located on the tracing, and its distance from the center line of the wheel-axis, R, V, is measured.

Let this distance (in inches) be R.

If w=0.26 lbs. be taken as the weight of the metal per cub. in., and W as the weight of the wheel, then W=2x3.1416 xRxRxW+weight of brackets and letters, minus weight of metal displaced by the core-legs of the pan-core. The constant 3.1416 is the ratio of the diameter of a circle to its circumference.

The calculation for No. 1 was made from the pattern-drawing for a 650-lb. wheel; that from No. 2 from the pattern-drawing for a 700-lb. wheel. The cleaned wheels made from these patterns are averaging 655, and from 700 to 705 lbs. respectively.

Since a variation of 2 per cent above or below the regular weight can be easily caused by variable molding in the making of a car wheel, it will be seen that the foregoing method of calculation gives reliable results. For casting of soft iron and of more regular shape than the car wheels results could be more easily obtained.

The planimeter is an example of an essentially practical instrument based upon principles of the higher mathematics, and, while the operation of the instrument is remarkably simple, it requires the reasoning of the calculus to demonstrate the mathematical proof of its good work.

"The Foundry."

ELECTRICAL.

An Example of Transformer Design

By John Howatt.

In the last article, the general outline of the method employed in designing a transformer was given. In this article the design will be taken up in a more specific way, by means of an example of the actual calculations necessary.

In this example, let the following conditions be assumed: The transformer to be for a lighting load, 1,000 watts capacity, 60 cycles, secondary voltage 115 or 230, primary voltage 1,150 or 2,300. Let a regulation of 3 per cent. be assumed and an efficiency of 94 per cent. This latter would be a low value for any large transformer, but it is as high as could be expected in a 1,000 watt transformer. As a further assumption, let the transformer be of the shell type, oil insulating and self-cooling.

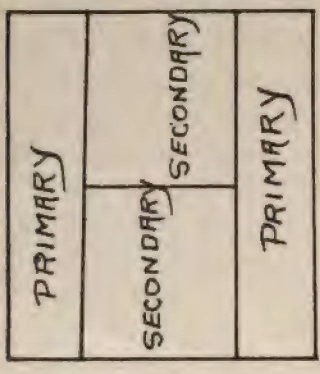


Fig 2,

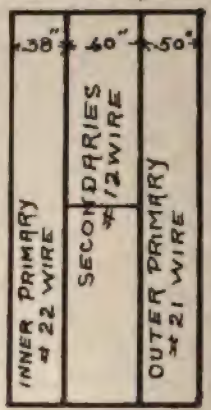


Fig 3

The first thing to be determined is the turns of wire in the primary and the secondary coils, and the total magnetic flux. Since the transformer is to be used on two different voltages, it is desirable to have at least two coils in the primary and two in the secondary, arranged to allow either to be connected in series or multiple for the different circuits on which the transformer is to be used.

Calling T the total number of primary turns, we have from the previous article:

$$T = \frac{E \times 10^8}{4.44 \times N \times \Phi}$$

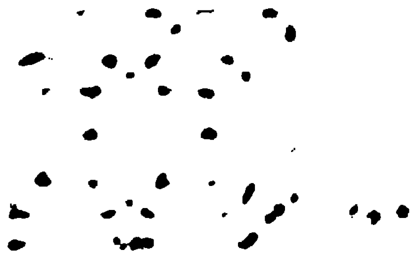
where E = primary voltage = 2300
N = frequency = 60
Φ = total magnetic flux.

Tables have been prepared, giving the different values of the flux O, as found in actual practice, the value depending on the size of the transformer and the frequency at which it is to be used. From these tables, the total flux for a 1,000-watt 60-cycle transformer is found to be about 300,000. Substituting this value for O in the above equation we have:

$$T = \frac{2300 \times 10^8}{4.44 \times 60 \times 300000} = 2880 \text{ turns.}$$

[illegible]

[illegible]



[illegible] the distance between the [illegible]

Since the outer primary coil is longer than the inner, two sizes of wire are chosen, No. 21 for the outer and No. 22 for the inner, in order to make the resistance of the two coils nearly equal. From a wire table we can now find the space that will be occupied by each coil. It will be found that the section of the first, or inner, primary coil, is 1.65 sq. in. The section of the outer primary is 2.2 sq. in. The section of each secondary coil is 1.25 sq. in. Then allowing ⅛" all around for insulating and circulation purposes, and making the windows 3⅛A long we obtain, for the dimensions of the window, 4.5 in. x 1.98 in. and the dimensions of the coil section as shown in Fig. 3.

The average length of turn for each coil can now be obtained. This is best done on a drawing board, but can be computed to a fair degree of accuracy. For the inner primary coil, the mean length of turn is found to be 14.6 in. Its total length is then

$$\frac{1440 \times 14.6}{12} = 1750 \text{ feet.}$$

1,750 feet. Its resistance at 50°C is .018x1,750=31.5 ohms.

The mean length of the secondary turns is 21.10 in. The total length of wire in each coil is then

$$\frac{144 \times 21.20}{12} = 252 \text{ feet.}$$

252 feet. The resistance per coil at 50°C is .44 ohms.

The mean length of the outer primary is 25.8 in. The total length is

$$\frac{1440 \times 25.8}{12} = 3050 \text{ feet.}$$

=3,050 feet. Its resistance is 34.5 ohms at 50°C.

The probable losses of the transformer are now computed, to see if the transformer comes up to requirements as to regulation and efficiency.

The core losses will first be computed. In order to do this the volume of iron in the core must be known. Fig. 1 gives a sketch, showing the dimensions of the completed core. Its volume is 118 cu. in., or 1,940 cu. cm.

Knowing the volume of iron, V, the hysteresis loss in watts is given by the formula: $Wa = 10^{-7} x N x V x N x B^{1.6}$, where N is a constant depending on the quality $Wa = 10^{-7} \times 1940 \times 60 \times .0025 \times 6000^{1.6} = 32.3$ watts.

The loss from eddy currents is found by the formula, $We = 1.645 x V (dNB)^2 x 10^{-11}$, where d is the thickness of the laminae in centimeters. Calling d=.03 cm. as a good working value, then $We = 1.645 \times 1940 (.03 \times 60 \times 6000)^2 \times 10^{-11}$, or We =3.7 watts.

Then the total core loss=Wa+We=36 watts.

Then the copper losses are next taken up.

The primary copper loss at full load= $I^2R = (.435)^2 \times 66 = 16.7$ watts.

The secondary copper loss at full load $= (4.35)^2 \times .88 = 13.4$ watts.

This gives a total copper loss at full load of about 30 watts: and the total transformer loss at full load will be 66 watts. Then the full load efficiency will be

$$\frac{1000}{1000+66} = 100 \times 93.8\%$$

Assuming a full load for 5 hours, and 19 hours each day no load, we have for the all day efficiency,

$$E = \frac{1000 \times 5}{(1000+66)5+(36 \times 19)} \times 100 = 83\%$$

Neglecting leakage, the drop at full load is found in this way: The primary IR drop at full load is 30 volts. Reduced to the secondary, this is 3 volts. The secondary full load drop is 3.9 volts. The total secondary drop of voltage then, from no load to full load, is 6.9 volts. The secondary voltage at no load being 230, the regulation obtained is 3 per cent. This is as good as can be expected on a 1,000-watt transformer.

HOME STUDY.

Mechanics

[illegible]

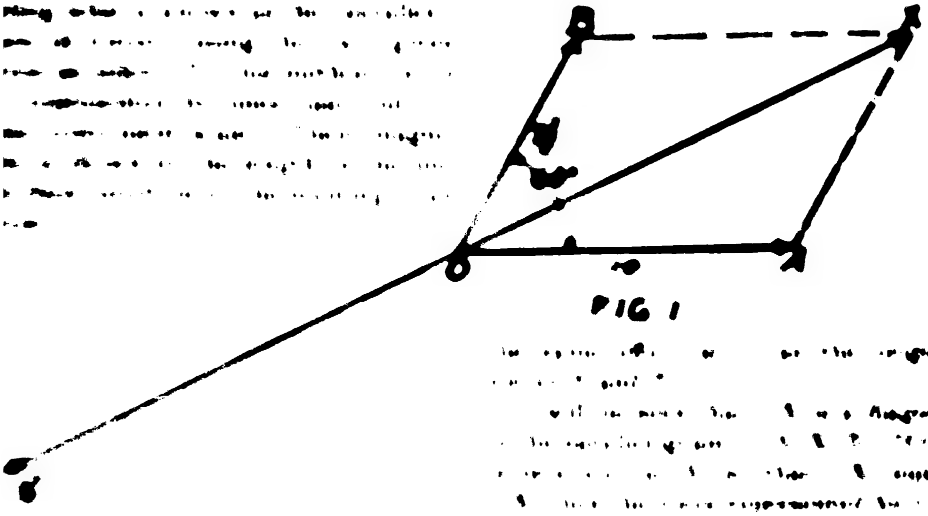


FIG 1

[illegible]

Suppose any number of forces in a plane are acting on a given point, then in order to find their resultant, the resultants of any two of them can be combined.

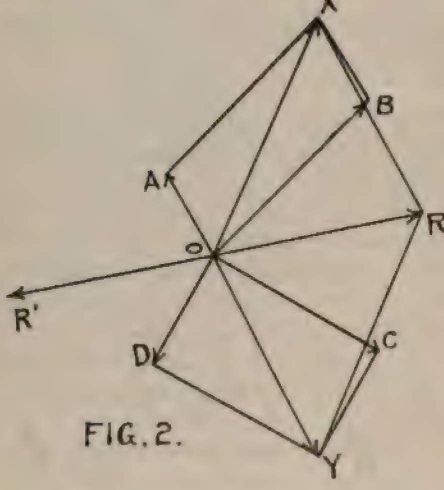


FIG. 2.

In Fig. 2, let ABCD be forces of 3, 4, 6 and 7 lbs. acting at O.

Lay off the forces to scale at the positions shown. Complete the parallelogram of forces on A and B and get the resultant OX, then using C and D get the resultant OY. Combine OX and OY and find OR as the resultant of the system. OR' equals OR is the anti-resultant which will balance the system.

If the given force in a system are not all in the same plane it can be shown that the resultant of the system is the diagonal of a parallelopiped, of which the given forces are the given edges.

If the forces in a system are all parallel, the resultant is the algebraic sum of the forces. In Fig. 3 the resultant equals (A plus D) minus (B plus C). The position of this resultant will be discussed later under the head of parallel forces and the center of gravity.

If we think of the resultant as the given force, it may be necessary to determine the amount of the forces along two or more directions, which when combined in the manner just shown will produce the given force.

These smaller forces are called "components" of the given force. If the direction of the components of a force are known, their value may be determined by proceeding backwards with the parallelogram of forces.

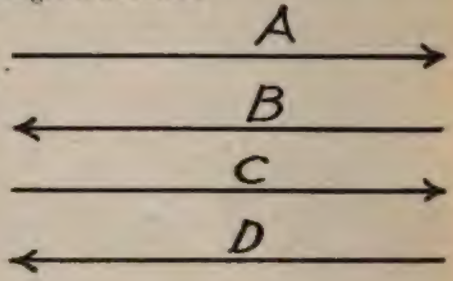


FIG. 3.

In Fig. 4 let OA represent the original force drawn to any scale known in amount and direction of its components, OX and OY, making the known angles A and B with it. Then through A draw a line parallel to OY and cutting OX, also through A draw a line parallel to OX and cutting OY. Then the portions cut off on OX and OY will represent the value of the components of OA. These values can be scaled off.

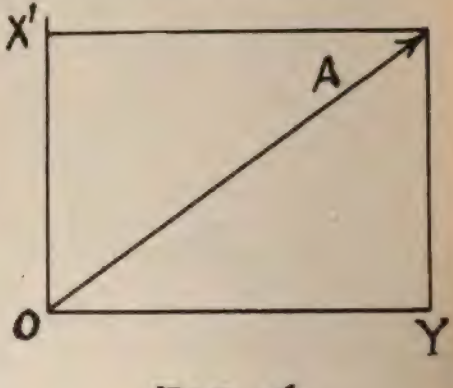
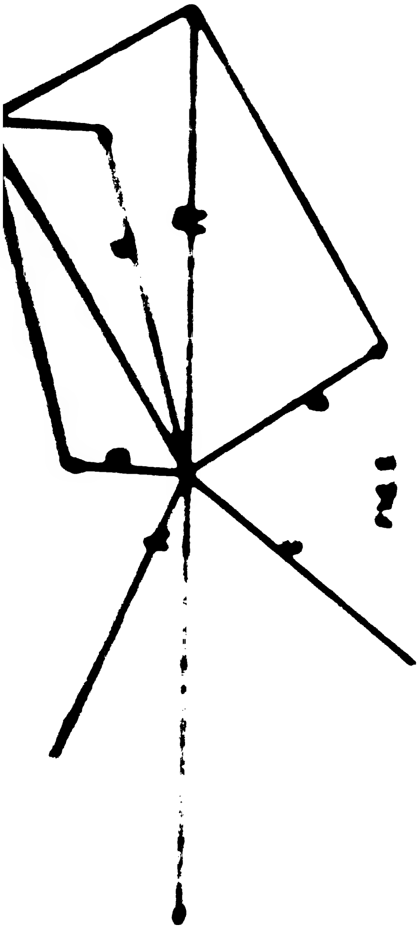


FIG. 4.

In such work as the solution of roof and bridge trusses it is often necessary to find the components of a force in order to determine what part of the whole load on the truss is carried to the supports by the various members.



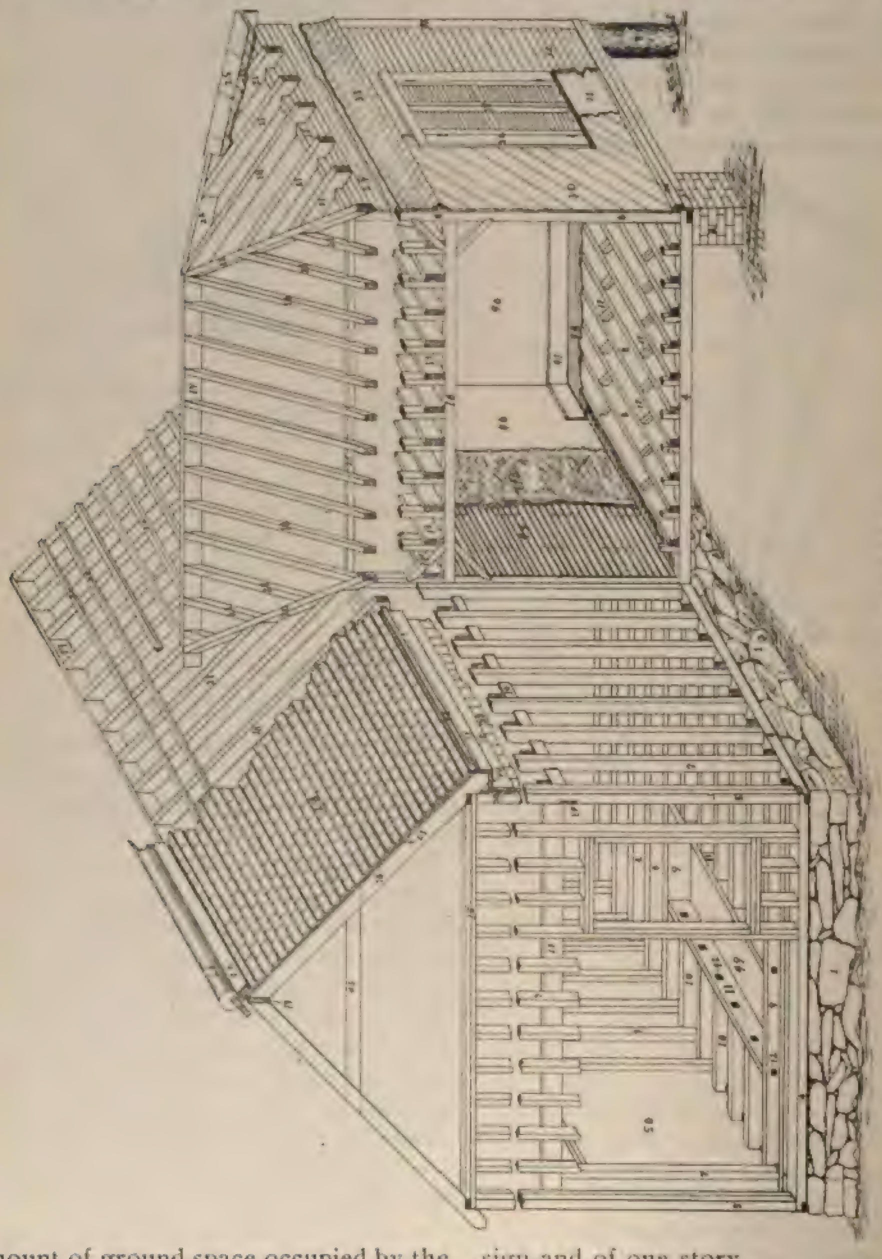
Elementary Course in Architectural

ing depending on the number of floors.

The arrangement of the rooms in the first story is the drawing that an architect would begin on to determine the amount of ground space occupied by the house. If the arrangement, as suggested, would make a large and expensive house, then his skill must determine the changes.

There are standard names applied to all the pieces and objects used in the building, and for convenience we will begin with a frame house of simple design and of one story.

Since the most readers were born and raised in a house of some kind, there are many things that need no description, such as doors, steps, windows,



HOUSE CHART

[illegible]

Lath

Rough flooring

Finished flooring

Baseboard

Flooring

[illegible]

INTERIOR CHART

[illegible]

Sill

[illegible]

Sheathing or rough boarding

Sheathing paper

Stud

13. Laths.
14. Plastering.
15. Architrave, interior casing or window trim.
16. Stop bead.
17. Parting bead or strip.
18. Pulley stile.
19. Sash weights.
20. Window latch or sash lock.
21. Pulley.
22. Sash cord.
23. Meeting rail of outside sash.
24. Meeting rail of inside sash.
24'. Bottom rail of sash.
24". Top rail of sash.
25. Stop head.
26. Window head.
27. Exterior casing.
28. Sash stile.
29. Astragal or sash bar.
30. Sash lift.
31. Window pane or glass.
32. Panel back or breast.
33. Base blocks.
34. Window trim, casing or architrave.
35. Corner block.
36. Window trim.

(The lists and illustrations are reproduced from an article by Mr. Albert Fair in "Self Education for Mechanics", published by The Industrial Publication Co., New York).

Mechanical Drawing Course II

Introduction.

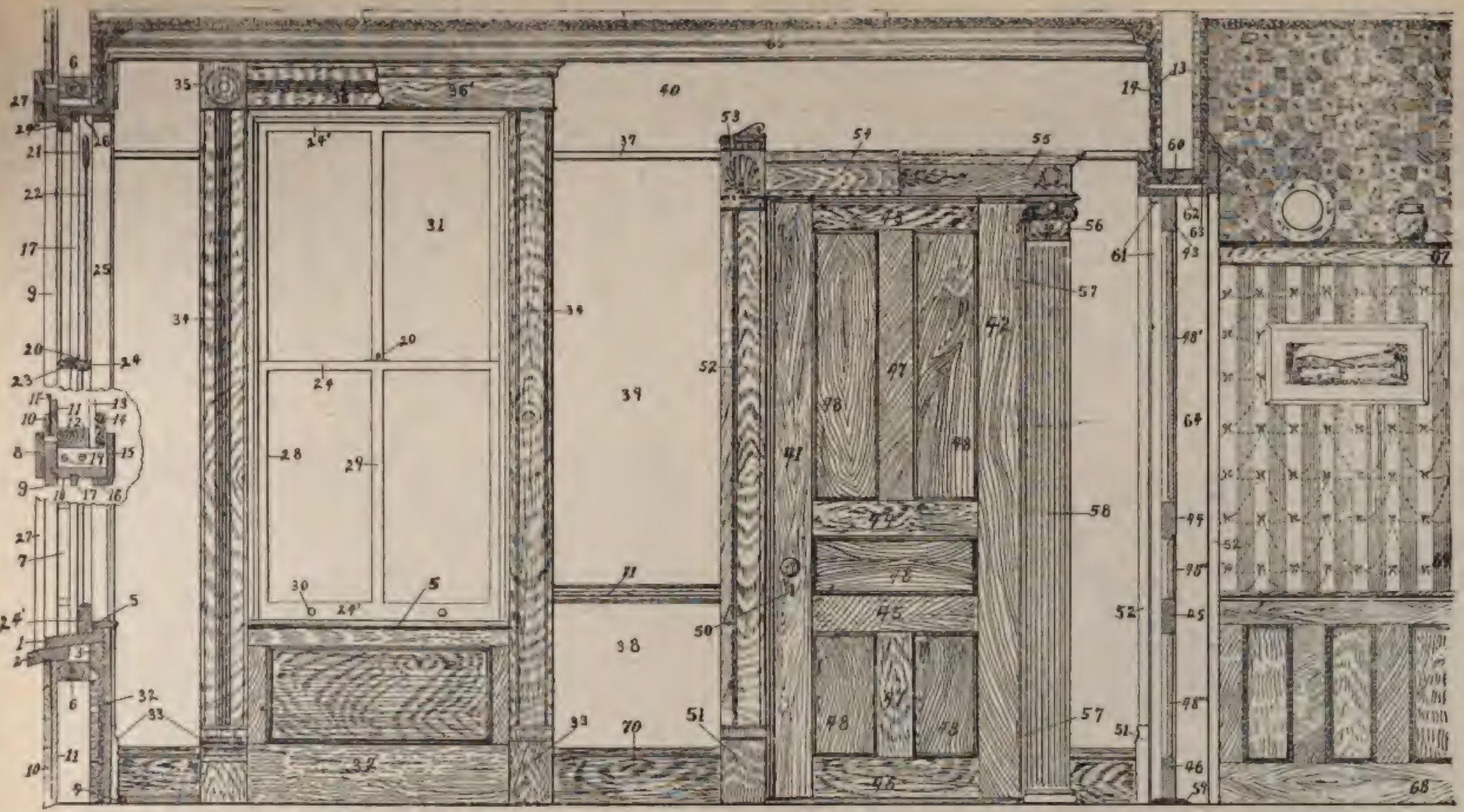
Before beginning the work of this course, the student is supposed to have completed Course I, of this series, on Elementary Mechanical Drawing. It is necessary for him to be familiar with the more common geometrical constructions, to understand what is meant by orthographic projection, and to be able to apply his knowledge. He should know how to make sections and developments of objects, and have enough knowledge of working drawings to enable him to take up the more advanced and difficult problems of this course without much hesitation. Any student who has completed Course I and the Intermediate Course, or their equivalent, should have no trouble in taking up the work outlined below.

This course will include sketching and drawing from the model, the working out of secondary views having given the principal view, a study of shafting, bearings, keyed, riveted and bolted connections, pipe fittings, pulleys, cams and gearing.

Each principal is illustrated by an example taken from actual practice. The course is adopted primarily for use in evening school work, where measurements can be taken from the model and where the pupil is under the direction of the teacher; but for the benefit of the Home Study Department, photographs of the models used will be published, and printed instructions will be published with the plates.

At this point the student is advised that it is time for him to begin to break away from the illustrations and descriptions of the text books, and to think things out for himself. These problems are planned to lead the student up to the practice of machine design, and while teaching him to think, they have been so chosen as to supply him with a fund of useful knowledge. It is hoped that the process of mental training can be made interesting by choosing the work that the student is required to do from actual probems found in every day engineering practice.

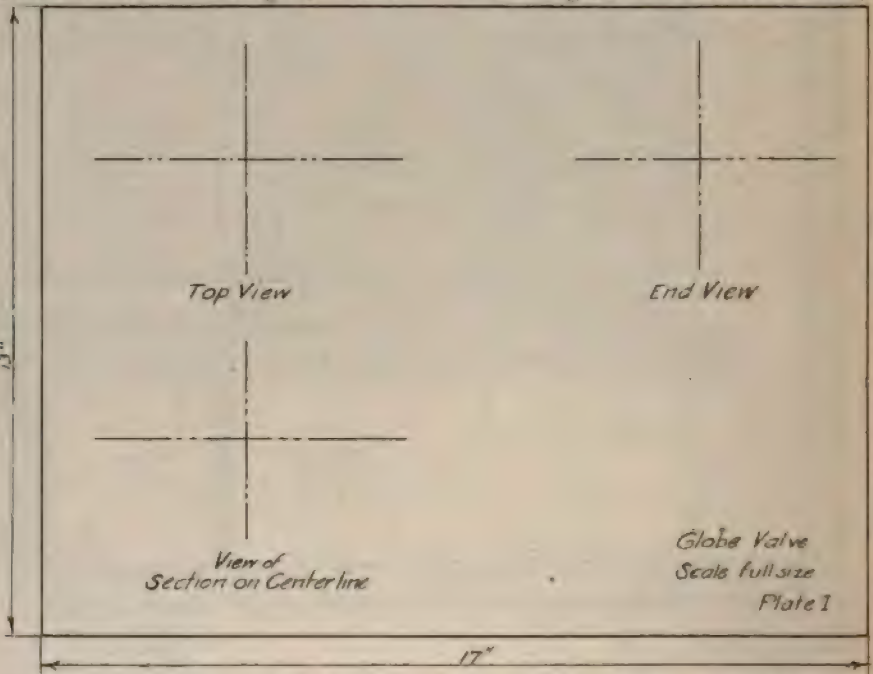
Too much emphasis cannot be laid on reading. Read the technical books and magazines, in connection with the work, and find out how others are doing things. A list of questions is given with each plate. These questions are put with the idea of directing the attention to the most important points, and



Interior Chart.

the student is advised to read up or inquire from experienced mechanics, and write out complete answers to all the questions. Following is a list of reference books and magazines:

"American Machinist", "Power", "Engineering News", "Engineering Record", "Engineering Magazine", "Cassiers Magazine", Unwin's "Machine Design", "Ripper's Steam", Stahl & Wood "Elementary Mechanism", Barr's "Kinematics", Benjamin's "Notes on Machine Design", Rose's "Steam Boilers", Kent's "Engineer's Pocket Book", Carnegie's "Pocket Book", Ried's "Elementary Drawing & Machine Design", Rose's "Pattern-Maker's Assistant", and "The Draftsman".



Sketch and Detail of A Globe Valve.
(From Model or Photograph).

Few designers are practical pattern-makers or machinists, but every draftsman who expects to get out work for the shop must know enough of each of these trades to enable him to furnish just the information that the mechanic wants. He should know what shapes can be easily manufactured and what cannot; he must be able to consider the "cost" of doing things, for it often happens in engineering that the "best" way is simply the cheapest way. Some knowledge of pattern-making is of the greatest importance to the young draftsman. Without being expected to know all the ins and outs of the trade, he will find that some practical knowledge of it is indispensable to his success as a designer. He should study the theory of it in the books and magazines and watch practical men at every opportunity.

On this plate we shall make a short study of patterns, as illustrated by a three-inch globe valve.

DIRECTIONS.

Make free hand sketches, showing three views of the model valve. One view is to be a section lengthwise through the center of the valve, one view is to be a plan looking down on top, as it stands in its upright position and the third view is taken looking at

the end. The model should be measured up with a "shrink rule", and all the dimensions put on the free hand sketches in good order. The three sketches may be made on separate pieces of paper. It is better to keep a note book for this purpose and preserve all sketches. After the free hand sketches have been checked by the instructor, the views may be laid out to scale in the order shown by the illustration, Plate I. The sectional view should be started first, and then the other views found by projection from it. Work all three views together, by so doing mistakes will be avoided.

The student is left to choose his own scale.

QUESTIONS.

1. What are some of the qualities of good pattern lumber?

2. What machines would you find in a well-equipped pattern shop, and what is the use of each?

3. How does the pattern-maker use the drawing furnished him by the draftsman?

4. What is a shrink rule, and why is it used?

5. What is a core box, and how is it used?

6. Define: Core print, draft, rapping, green sand, dry sand, cope, drag, flask, mold.

7. Name in their order, and describe in about two hundred words, the processes that the pattern-maker goes through in building up his pattern.

8. Estimate the weight of the casting from the model globe valve. (See a table of specific gravity).

9. How much will the rough castings cost apiece?

10. Find out the market value of a valve of this size, and make an approximate statement, showing cost of rough casting, finishing, dealers' profits, etc.

Course I was completed in August issue of THE DRAFTSMAN, and anyone who would like to take up the lessons may secure them in booklet form by writing to this magazine.

In The World of Science.

In a paper read by Arthur Gulston, a British engineer, before the Society of Arts, some remarkable facts were stated regarding the work of vessels built for breaking ice in navigable channels. Mr. Gulston rates the Ermack, a Russian steamer intended chiefly for use in the Baltic Sea, the most powerful of these modern aids to winter navigation in cold countries. The Ermack is 335 feet long, and has remarkable breadth of beam, the extreme being 71 feet. The displacement of the ship is 8,000 tons, and her draught of water is 22 feet. In solid ice two feet thick, covered with from six to twelve inches of snow, the Ermack can make ten miles an hour, while in the Arctic Ocean the vessel has broken up and forced a passage through packs of ice twenty to thirty-five feet thick.

In a curious article on the "Life and Diseases of Metals," published in Harper's Magazine for April, Professor Heyn, of the Technical Experiment Station of the Royal Polytechnic School, at Berlin-Charlottenburg, asserts that metals can be poisoned, much as animals often are, and that metals so diseased may be brought back to normal condition again, in many cases, by proper treatment with remedies which may fairly be likened to the medicines used as antidotes for poisons in protecting human life. Professor Heyn brings forward much evidence, microscopic and physical, to show that the growth of vegetables can be so closely paralleled in minerals when favorable conditions are created, that the effect upon the observer of the process of accretion is to suggest that the line of division between organic and inorganic substances is by no means so clear and certain as it is commonly supposed to be.

CURRENT TOPICS.

The Other Fellows

—The other fellow's job

There's a craze among us mortals that
 is cruel hard to name,
Wheresoe'er you find a human you will
 find the case the same;
You may seek among the worst of men
 or seek among the best,
And you'll find that every person is
 precisely like the rest.
Each believes that his real calling is
 along some other line
Than the one at which he's working—
 take, for instance, yours and mine.
From the meanest "me-too" creature to
 the leader of the mob,
There's a universal craving for "the
 other fellow's job."
There are millions of positions in the
 busy world today,
Each a drudge to him who holds it, but
 to him who doesn't, play;
Every farmer's broken-hearted that in
 youth he missed his call,
While that same unhappy farmer is the
 envy of us all.
Any task you care to mention seems a
 vastly better lot
Than the one especial something which
 you happen to have got.
There's but one sure way to smother
 envy's heartache and her sob:
Keep too busy at your own, to want
 "the other fellow's job."

—Strickland W. Gillilan, in Success.

Electric welding of metals is fast becoming more important and more common in the manufacture of carriages, agricultural machinery, automobiles, bicycles, and other like industries. Among the advantages claimed for the electric process are rapidity, flexibility, cleanliness, neatness, accuracy, and economy.

In the rush to get in a large press and the delay of the August issue, the supplement was omitted, but two copies will be found in this issue.

There will be none in October issue, but two in November and two in January, and perhaps one each month thereafter.

One subscription has been received for five years for three dollars. We would like to have as many as possible.

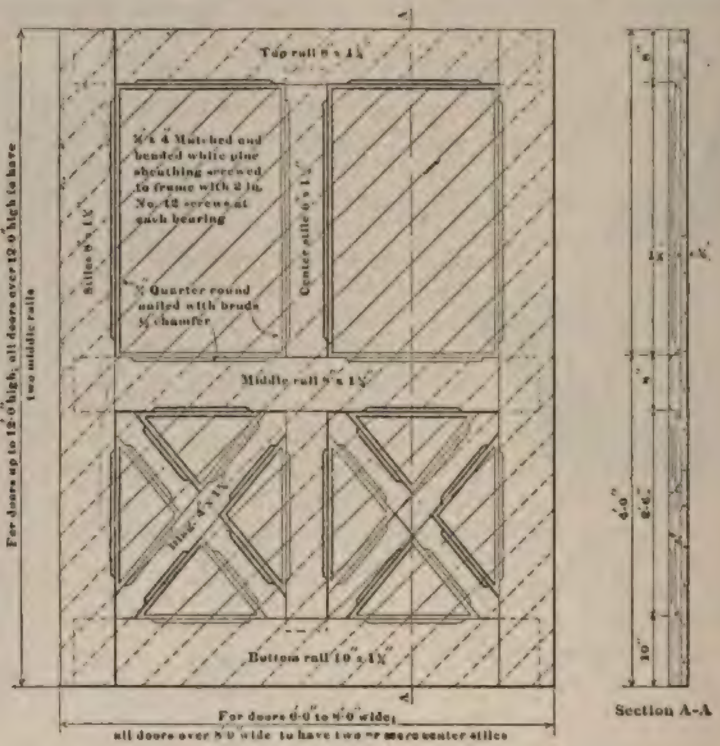
Our "want" columns were greatly revised in the August issue, and there is much new matter there now.

Always mention THE DRAFTSMAN, when writing to advertisers.

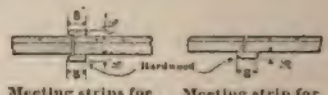
There are many ways of earning a subscription or premium with this magazine. Write for lists and catalogues of books.

Some of the newest types of heavy locomotives place the weight of the whole engine on a few drive-wheels, so close together that the strain on bridges from the use of such tremendously heavy machines must be serious. An electric locomotive, built for the New York Central Railroad Company, has its front and rear driving wheels only thirteen feet apart, and there are eight wheels, each carrying 17,000 pounds. That puts sixty-eight tons on thirteen feet of track.

STANDARD DOOR

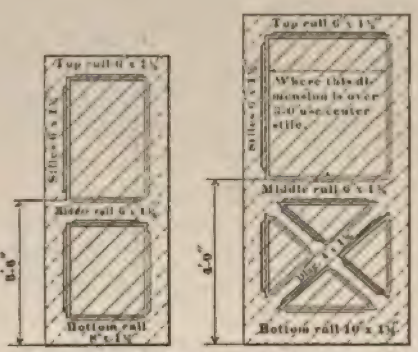


Section A-A



Meeting strips for double sliding doors.   Meeting strip for double swing doors.

Doors may be either slide or swing. Sliding doors should be 4" wider and 2" higher than clear opening between jambs.
All doors under 6'-0" wide to have 1⅜" stiles and rails.
All doors over 6'-0" wide to have 1¾" stiles and rails.
All stiles and rails to be halved or mortised and tenoned together.
Doors to be made of white pine
If doors are to be covered with tin or sheet metal they are to be made of two or more thicknesses of ⅞" matched white pine sheathing not over 4" wide, laid diagonally and put together with wrought nails well clinched.



Design for door up to 3'-0" x 7'-0"   Design for doors over 3'-0" x 7'-0" and up to 6'-0" wide

Taken from Book of Standards of Brown Hoisting Machine Co., Cleveland, Ohio.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

DETAILS OF PROPELLER DESIGN.

CARL H. CLARK.

The general dimensions of the propeller having been determined and the shape of the blade and hub outlined and projected, the details of the design may now be considered.

In a solid propeller it is evident that the size of the hub will be dependent upon the size of the shaft; this does not follow in a built up wheel, where the hub must be great enough in circumference to accommodate the flanges of the blades.

The size of the shaft can be readily figured from the I. H. P. by the usual methods of figuring shafting, using as the effective horse power .80 or .85 of the I. H. P., and a low fiber stress. The end of the shaft fitting into the propeller is turned taper, about ¾" or 1" to the foot, being customary; this tapered portion is made slightly shorter than the hub, so that the nut on the rear will always bed fairly on the hub, and not bring up on the end of the taper. The end of the tail shaft is covered with a composition sleeve, shrunk on, to give a bearing in the stern tube and also to prevent corrosion of the tail shaft. This sleeve enters the hub as in Fig. 1, and is carefully caulked and made watertight. The key must be slightly smaller than would be required for a straight shaft, on account of the taper. It is set into a keyway with rounded ends as shown, while the keyway in the hub is cut all the way across. The end of the shaft beyond the hub is turned down smaller than the small end of the taper and threaded, and a nut is fitted to hold the propeller in place. With a right-handed propeller the nut should screw on left-handed, and vice versa. Some efficient means of locking this nut is also to be provided.

The length of the hub is about 2½ to 2¾ times the diameter of the shaft, and its diameter, for solid propellers, is 2 or 2½ times the diameter of the shaft. In a built-up wheel, the hub, with the flanges of the blades, is of nearly spherical form. The seats for the blades are counterbored, usually

with sloping sides, although they are sometimes bored straight with only a short bevel near the upper edge. The object of the taper is to bring the blade up to a firm bearing, and it must bear on the tapered side and on the bottom at the same time. As will be noticed in Fig. 2 only a ring around the seat is finished, the center being cored out to save weight and labor in turning. Around the bolts which hold the blades in place the seat is enlarged to take them.

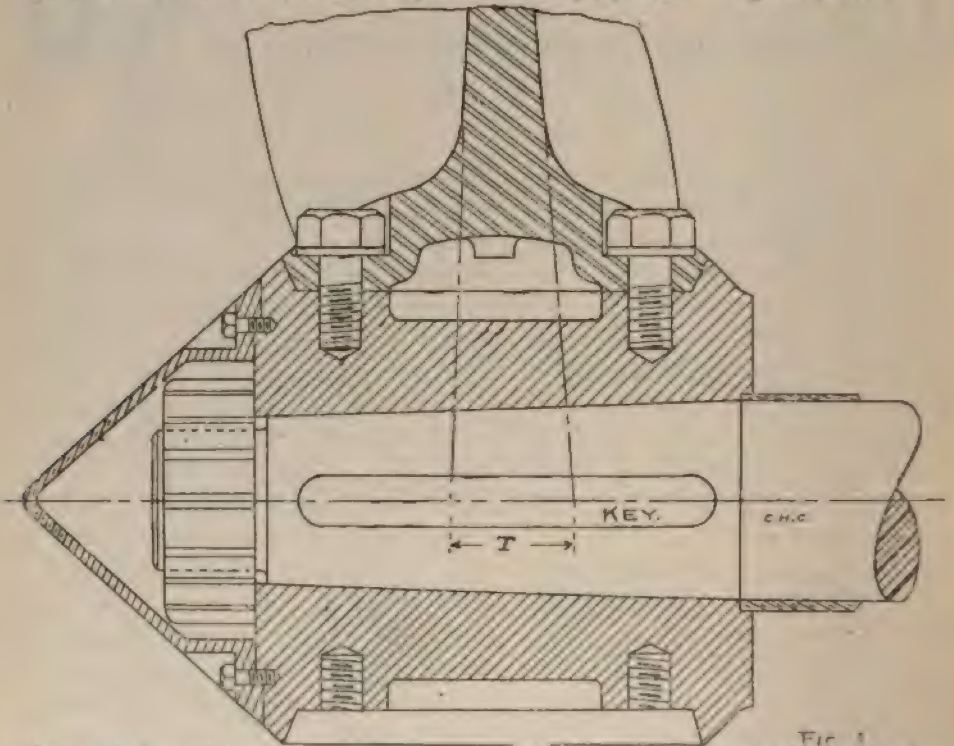


Fig. 1

The thickness of the blades varies from the base to the tip. This thickness at the tip is a very variable quantity, but will be found to be, for cast iron propellers, from $\frac{5}{8}$-inch in a small wheel, to an inch or more in a large one. For composition it will be somewhat less. The thickness at the root of the blade is very largely a matter of experience or very careful calculation. For a fairly close approximation, however, to the results obtained in practice, the taper of the blade may be extended to the shaft center and the thickness measured at that point as shown in Fig. 1 at *T*. This thickness may then be figured as a certain proportion of the diameter of the shaft. A table of these proportions is given below:

Solid cast iron wheel, 4 blades, T=.65 diameter shaft.

Solid cast iron wheel, 3 blades, T=.75 diameter shaft.

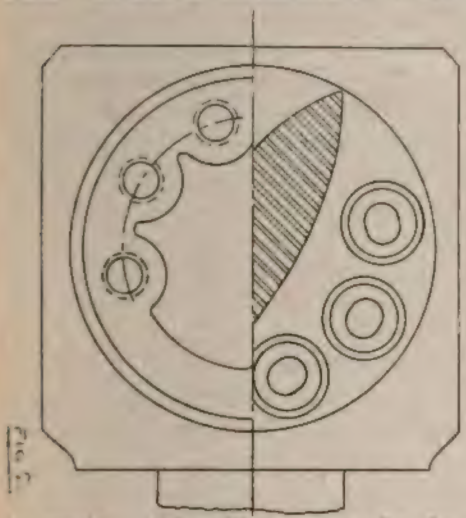
Built cast iron wheel, 4 blades, T=.70 diameter shaft.

Built (bronze or steel) wheel, 4 blades, T=.45 diameter shaft.

Built (bronze or steel) wheel, 3

blades, T=.55 diameter shaft.

It should be noted that the thickness thus found is for propellers of the usual proportions and that for other conditions modifications must



be made. The thickness at the tip does not, of course, mean at the extreme edge, as the edges are rounded off in order to create less disturbance.

The bolts holding the blade in place are from 6 to 10, according to the size. They are seldom less than 2½ inches in diameter. It will be noted that the holes in the blade are elongated; this allows a slight adjustment of the pitch by turning the blade slightly.

The cap over the nut is of the same material as the hub and is designed to protect the nut and also to give a fair, even surface for the water to pass along, thus avoiding some disturbance. It is carefully turned to fit the end of the hub, and bolted on with tap bolts. The holes around these bolts, and also around the heads of the flange bolts, are filled with cement, to exclude water, and prevent damage.

It is also customary in many cases to fasten a zinc ring on the front face of the hub to prevent the galvanic action between it and the bronze sleeve, or bronze blades, when such are fitted, the zincs being eaten away before the iron is attacked.

What Constitutes a Seamless Tube?

Henry Souther said, in the discussion of this question, that the scientific and technical designation of a tube, whether seamed or seamless, depended solely upon the tube itself, and not upon the process followed in its manufacture. Referring to the dictionary you will find that the word "seamless" means without seam, which conveys no light upon the subject. Turning to the word "seam" it is found that it is defined as a joint, suture, or line of union, and here in the last term we find the key. A tube jointed in any way cannot be seamless. If, in the primary stages of its manufacture, it be lap, butt or lock-jointed, it cannot by any subsequent operation be deprived of the seam, and therefore cannot be considered, when completed, as being seamless. A strictly seamless tube may be made by any one of three operations. First, a billet may be, by successive steps, punched into the form of a tube with extremely thick sides; and these may then, by the ordinary drawing processes, be re-

duced to a tube with thin walls. Next, the billet may be bored, or the blank may be cast with a hole in it, and in either case then drawn to the required dimensions. Thirdly, the tube may be made by the cupping process, which consists in taking a disk of the metal, forming it into a cup shape, gradually elongating the cup and reducing it in diameter, and finally by this means producing a tube. Each and all ot these processes yield a tube which is absolutely seamless and about which there is and can be no dispute. In all tubes formed with a seam the edges have first been separated, then united, either by lap or butt weld, or by some lock-joint system, and in these the joint cannot be eliminated by any after processes. The Custom House of the United States recognizes the difference between a seam and a seamless tube. A seamless tube is one in which the walls have never been separated from the time the metal was in a molten condition to the time of the completion of the tube.

Mechanical Squibs.

Speed of Shafting—

Machine Shops ....120 to 180
Wood Working ....250 to 300
Cotton and Woolen Mills.300 to 400

There are in some factories lines 1,000 feet long, the power being applied at the middle.—From Kent.

Size of Keys—

Width of key=¼ diameter of shaft.

Thickness of key=1-6 diameter of shaft.

Key-Ways—

Depth in hub of straight key-way =½ thickness of key.

Depth in hub of taper key-way= large end=3-5 thickness of key.

Standard taper of all keys=3-16 inch in one foot.

One of the advantages suggested for the steam turbine is the possibility of utilizing its waste or exhaust steam for heating buildings or vessels in which such engines are used.

Screw spikes are in general use in Europe for fastening rails to ties.

One difference between the giant redwood trees of the United States and the giant eucalyptus of Australia is that the redwoods require almost a century to attain any really remarkable growth, while the eucalyptus actually shoots up, growing with a speed that is more typical of a weed than of a tree.

A machine has been invented which is capable of splitting wood two feet long and eighteen inches thick. It is run by a three-horse power gasoline engine, and consists of a huge knife which works through the knottiest wood at the rate of sixty strokes a minute.

The locomotive is expected to go a hundred miles an hour, and exceed in power any steam locomotive on the road, having from 2,300 to 2,500 horsepower, as compared with 1,500 of the fastest passenger engine. The test will begin in a few days. The electric locomotives are to be used in the Park Avenue tunnel.—Troy Special to New York Tribune.

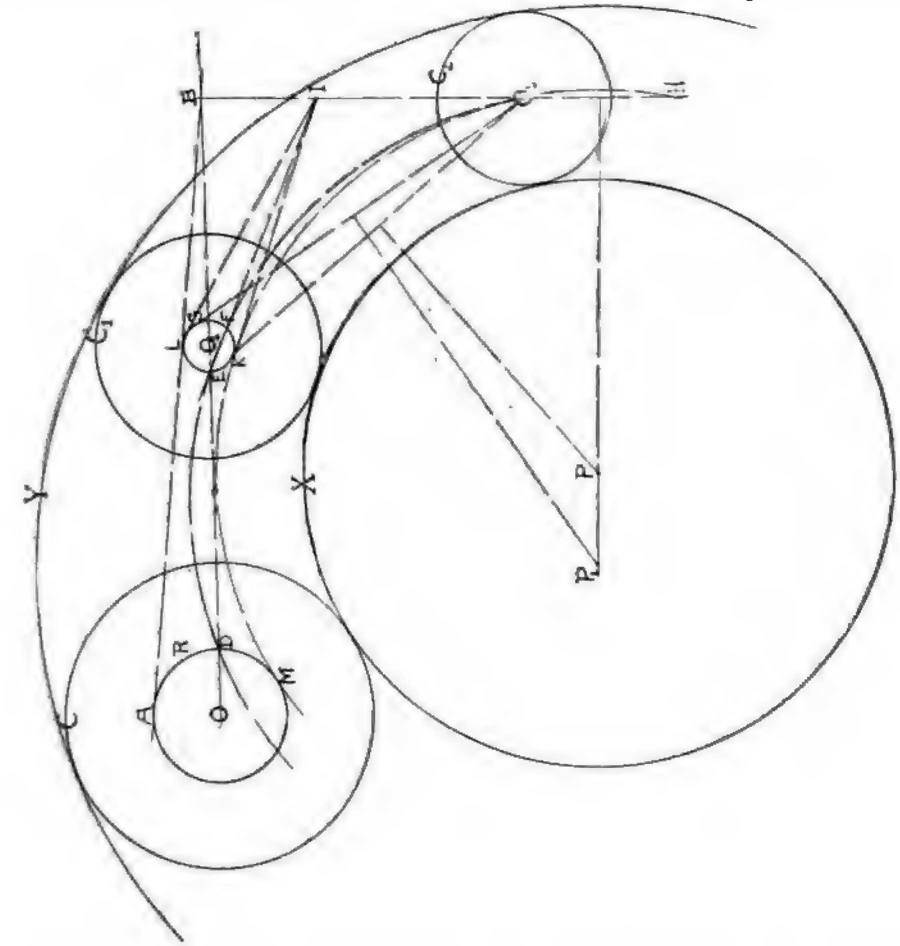
To Draw A Circle Tangent To Three Given Circles.

A METHOD ADMITTING OF A RIGOROUS GEOMETRICAL PROOF.

By A. L. Abbott.

TO THREE GIVEN CIRCLES.

Let the circles be denoted by C, C_1 and C_2, and let C be the largest, C_1 the medium, and C_2 the smallest.



With O as a center, and with a radius equal to the difference of the radii of C and C_2, describe a circle R. With O as a center and a radius equal to the difference of the radii of C_1 and C_2, describe a circle S. Draw AB the common tangent to these two circles; let B be the point in which this tangent cuts the center line OO_1 B; draw BO_2.

Draw a circle through D, E and O_2; this circle intersects BO_2 at some point H.

Draw any circle throug H and O_2 which will intersect either circles S or R. (In most cases the circle which has been drawn through the points

D, E and O_2 will answer without drawing an extra circle.) This circle intersects circle S in the points E and F.

Draw a line connecting these points and produce it until it meets BH at I, from I draw a tangent to the circle S tangent at the point K.

Find the center of the circle which will go through K, O_2 and H. This point P is the center of the required circle X.

Two Constructions are possible. If the tangent IK had been drawn to the other side of the circle S the dotted line construction would give P_1, which is the center of the circle Y.

There are several special constructions which may be met with, but which can be easily solved with a little thought. For example, suppose circles C and C_1 are equal, then AL will be parallel to OO_1, and consequently O_2B must be drawn parallel to OO_1 also. Again suppose O_2 and H coincide, P would be at the intersection of the perpendicular bisector of KO_2 and a perpendicular to BO_2 at the point O_2.

The above construction will hold good for any position of the circles, whether they intersect or not. If all three circles have their centers in the

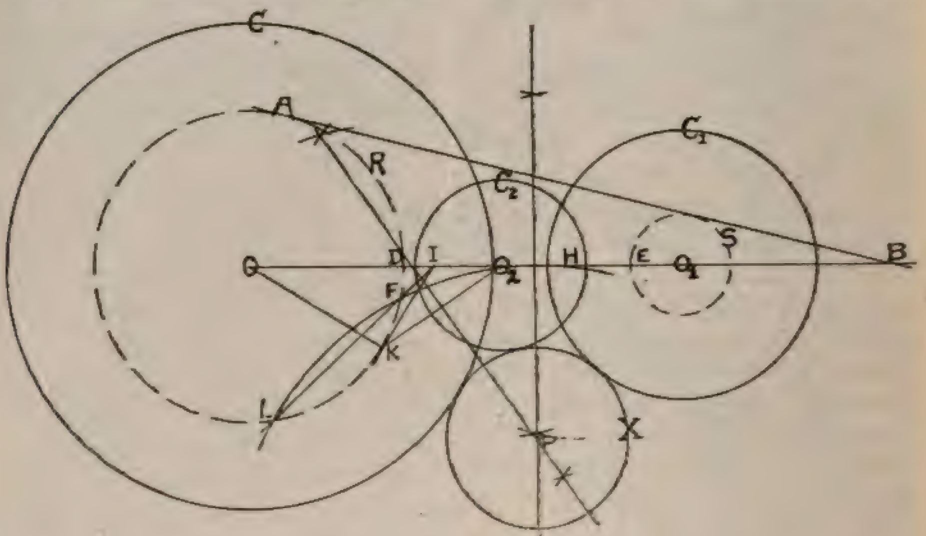


Fig 2

same straight line, the point H cannot be determined as above, but must must be done as follows; draw the secondary circles R and S, as before, also the line AB. Measure BD, BE and BO_2. Multiply the length by BE and divide by BO_2, make BH equal to this length. The rest is done exactly as before. The point H can be determined by this calculation for all cases, if desired, then the circle need not be constructed through D, E and O_2.

Fig. 2 shows the construction where circles are in the same straight line. I also drew the circles intersecting to show that it did not affect the results.

(*The first correct solution of this problem was given by Apollonius, a Greek, who lived 200 years B. C.)

STRUCTURAL.

SELF SUPPORTING STEEL CHIMNEYS.

By Wynkoop Kiersted,
M. Am. Soc. C. E.

The practising engineer always welcomes a short and comprehensive formula to aid him in his calculations, and realizes that for the sake of simplicity and ease of application, factors which theoretically belong in a formula may sometimes be dropped without affecting the accuracy of the results derived from a solution of a formula within practical limits. The writer presented a formula of this kind for computing the thickness of metal required in empty standpipes to resist the strain caused by wind pressure, in a paper which appeared in Volume II. of "Selected Papers of the Rensselaer Society of Engineers," June, 1889.

The same formula in a slightly modified form is useful in proportioning the diameter and thickness of metal of self-supporting steel chimneys.

It is $x = \sqrt{F\ T \div p} = \frac{1}{4} \sqrt{T\ d\ t}$ where x is the height of chimney, T is the allowable unit working strain in the metal, F is the area of metal in a horizontal section of the shell, and p is the wind pressure on a unit of surface, or 50 pounds per square foot of plain surface.

The formula may be simplified by substituting numerical values for the several unknown factors, as follows:

F equals π d t when d is the diameter and t the thickness of the metal of the shell. T, the working stress, is dependent for its value upon the strength of the riveted joint. The area of rivets in a well proportioned lap joint is about 77 per cent. of that of a horizontal section of the shell. Assume the available safe shear on the rivets to resist wind pressure to be 7,500 pounds per square inch, less the shear induced by the weight of the shell, which shear by trial is found to be 320 pounds per square inch of rivet section, leaving 7,180 as the available rivet shearing strain, equivalent to 5,528 pounds per square inch of shell section. Hence, $x = 18.6 \sqrt{d\ t}$. The derivation of the formula is to be found in the paper alluded to and is here given substantially as described 15 years ago.

The conditions for the severest overturning wind strains exist when the structure is empty. The thickness of the metal and the joints should be so proportioned as to be proof against crippling when under strain. The proportions of the structure may be determined by considering it as a semi-girder standing erect, with a static force applied in a horizontal direction equivalent to the force of the wind upon the exposed surface at the usually assumed maximum amount

For sake of simplicity, the weight of the structure may be disregarded, and in the discussion no account is taken of this weight. The general formula for bending moment of a semi-girder, tubular in section, is

$$Pl = \frac{\pi}{4} \frac{(r_1^4 - r_2^4)}{r_1} T$$

where r_1 = exterior radius of stand pipe,
r_2 = interior radius of stand pipe,
$r = \frac{1}{2}(r_1 + r_2)$ = mean radius,
$F = \pi(r_1^2 - r_2^2)$ = area of horizontal section of metal ring,
$t = (r_1 - r_2)$ = thickness of plate,
T = working strength of metal,
Pl = moment of external force.

$$\therefore Pl = \frac{\pi}{4} \frac{[(r_1^2 - r_2^2)(r_1^2 + r_2^2)]}{r_1} T$$

By substitution $Pl = \frac{F}{4} \left\{ \frac{2r^2 + \frac{t^2}{2}}{r_1} \right\} T =$

$$\frac{F}{4} \left\{ \frac{2r^2 + \frac{t^2}{2}}{r + \frac{t}{2}} \right\} T = \left\{ \frac{4r^2 + t^2}{4(2r+t)} \right\} FT =$$

$$CFT = \frac{pdx^2}{4}$$

$$x = \sqrt{\frac{4CFT}{dp}} = \sqrt{C} \times 2\sqrt{\frac{FT}{pd}}$$

where p = wind pressure per unit area or 50 pounds per square foot,
d = diameter of chimney = 2r,
x = any unknown height of chimney,
$\frac{1}{2}x$ = any lever arm of overturning force; the wind pressure on a cylindrical surface being considered as one-half that on a diametric section.

$$C = \frac{2r^2 + t^2}{4(2r+t)}$$

In this value of C it can be readily inferred that t is practically unimportant, and can be dropped. A few mathematical tests will fully demonstrate this.

Hence the value of C becomes equal to $\frac{1}{4}$ r, and

$$x = \sqrt{\tfrac{1}{4}r} \times \sqrt{\frac{4FT}{dp}} = \sqrt{\frac{FT}{p}} = .25\sqrt{Tdt}$$

It is assumed, of course, that the anchorage of the chimney is secure and that the weight of the foundation is sufficient to resist the overturning effect of the wind.

—*The Engineering Record.*

SMILES.

As Always.

"What is your occupation, may I ask?" inquired the passenger with the skull cap.

"Map-maker," said the passenger in the long linen duster.

"Publisher, eh?"

"No. Draftsman."—Chicago Tribune.

HOME STUDY.

Strength of Materials.
Introduction.

This subject is in itself a large one. It will not be possible in this small work to cover the matter in an extended manner.

It is only with a view to acquaint the student with some of the leading points in "Strength of Materials" that the following matter was compiled.

The matter of this series of articles was compiled from various sources, and the writer wishes to give credit to Reid's "Mechanical Drawing and Machine Design," Merriman's "Mechanics of Materials," Goodman's "Mechanics Applied to Engineering," Kent's "Mechanical Engineer's Pocket Book."

The series will treat, first, definitions, general formulæ and tables, then following with strength of screw threads and bolts, cylinders, rivited joints, beams, shafts, columns, etc., etc.

DEFINITIONS.

The *load* of any part of a machine or structure is the total of all external forces acting upon it.

A *live* load is a variable one, applied and removed continuously.

A *dead*, or constant load, is that which has a continuous steady action on the machine or structure.

The *useful* load is that which the machine or structure is designed to carry outside of itself.

Resistance of a material to change its form is due to the inherent cohesive force of its molecules.

Elasticity or spring, is the characteristic of the material to regain its original form after an external load has been removed.

The elastic limit is the maximum extension or compression to which a material can be subjected without permanent set.

Stress and *Strain*—If we were to make any number of sections of a body and it were found that there was no tendency for one part of it to move relative to any other part, that body is said to be in a *state of ease*; but when one part tends to move relative to the other part, we know that the body is acted upon by equal and opposite forces and the body is said to be in a *state of stress*.

Thus, if we were to make a series of saw cuts in a plate of metal and the cuts were found to open or close before the saw was through, we would know that the plate was in a state of stress because the one part tends to move relatively to the other.

The stress is due either to external forces acting on the plate or to internal initial stresses in the material, such as is often found in badly handled castings or in cold rolled shafting.

The strain of a body is the change

of form or dimensions that it undergoes when placed in a state of stress.

If the load does not place the material beyond its elastic limit, the strain will disappear when the stress is removed.

No bodies are absolutely rigid; they all yield, or are strained more or less, when subjected to stress, however small.

A material may be loaded so that the stress will act in one or a combination of forms: if pulling, in *tension;* if pushing, in *compression;* if cross-cutting, in *shear;* if twisting, it produces *torsion*, and the body may be put under both a push and a pull, as in bending.

Then the strength of a material is its resistance to one or the other of these forms of stress: *Tensile* strength, to resist being pulled apart, as a rope; *compressive* strength, as in the foundation of a house; *tortional* strength, as in a shaft; *shearing,* as in the case of a rivet or bolt, though these are often in tension, too.

The cutting of a plate with a pair of shears is a better example of the latter kind of strength.

Bending is a combination of tension and compression.

When the molecules of a body part, it is said to be fractured. A fracture may appear when the load becomes great enough to cause permanent set.

The final, or ultimate strength, is the smallest load that will fracture a member, and machine members should be designed strong enough to resist permanent set under the maximum load.

Stresses are measured in pounds, tons, or kilograms.

A *unit stress* is the amount of stress on a unit of area, and is expressed in pounds per square inch, or in kilograms per square centimeter.

Within the elastic limit, it is found that stress and strain are proportional, and this had led to an investigation to determine some means of concisely expressing the amount of strain that a body undergoes when subjected to a given stress.

The usual method of doing this is to state the intensity of stress required to strain the bar by an amount equal to twice its own length, assuming the *material to remain perfectly elastic.*

It need hardly be pointed out that no material used by engineers will remain perfectly elastic when pulled out to twice its original length; in fact, very few materials will stretch much more than *one thousandth* of their length and remain elastic.

This ratio of strain to stress is known as the *modulus of* (or measure of) *elasticity*, and may be expressed thus:—

$$E.— \frac{\text{Stress per sq. in. in lbs.}}{\text{Strain per inch of length.}}$$

When all is within the elastic limit.

This formula was deduced by Dr. Thomas Young in 1826 and is known as "Young's Formula."

From the above it might be said that the Modulus of Elasticity is the ratio of a unit stress to a unit strain.

The values of the *modulus of elasticity* for different material is given in the table under heading of "Data From Experimental Sources."

When the machine or structure is being designed, we would not want to

put on it a useful or working load equal to its ultimate or breaking strength for fear of rupture, but arrange for a certain degree of safety.

This degree of safety is the ratio of the ultimate strength to the working load, and is known as the *factor of safety*.

The factor of safety for a piece to be designed is the ratio of the ultimate strength to the proper allowable working strength.

Thus: If *St* be the ultimate, *S* the breaking strength, and *f* the factor of safety, then

$$f=\frac{St}{S} \text{ and } St=fs.$$

The factor of safety is always an abstract number, which indicates the number of times the working stress may be multiplied before the rupture of the body will take place.

It is evident that working stress should be lower where shocks occur than where a steady even load is applied, hence the factor of safety would be higher.

In a building the working stresses are steady; in a bridge they vary, and the factor in the first case could be small while in the latter much greater.

The following are average values of the allowable factors of safety commonly employed in American practice:

Material.	For study stress.	For varying stress.	For shocks.
Timber	8	10	15
Brick & stone	15	25	30
Cast iron	6	15	20
Wrought iron	4	6	10
Steel	5	7	15

These values are subject to considerable variation in particular instances, not only on account of the different qualities and grades of the material, but also on account of the varying judgment of designers.

They will also vary with the range of varying stress so that different parts of a bridge will have very different factors of safety.

COURSE II MECHANICAL DRAWING.

CHAPTER II.

The Cylinder-Castings.

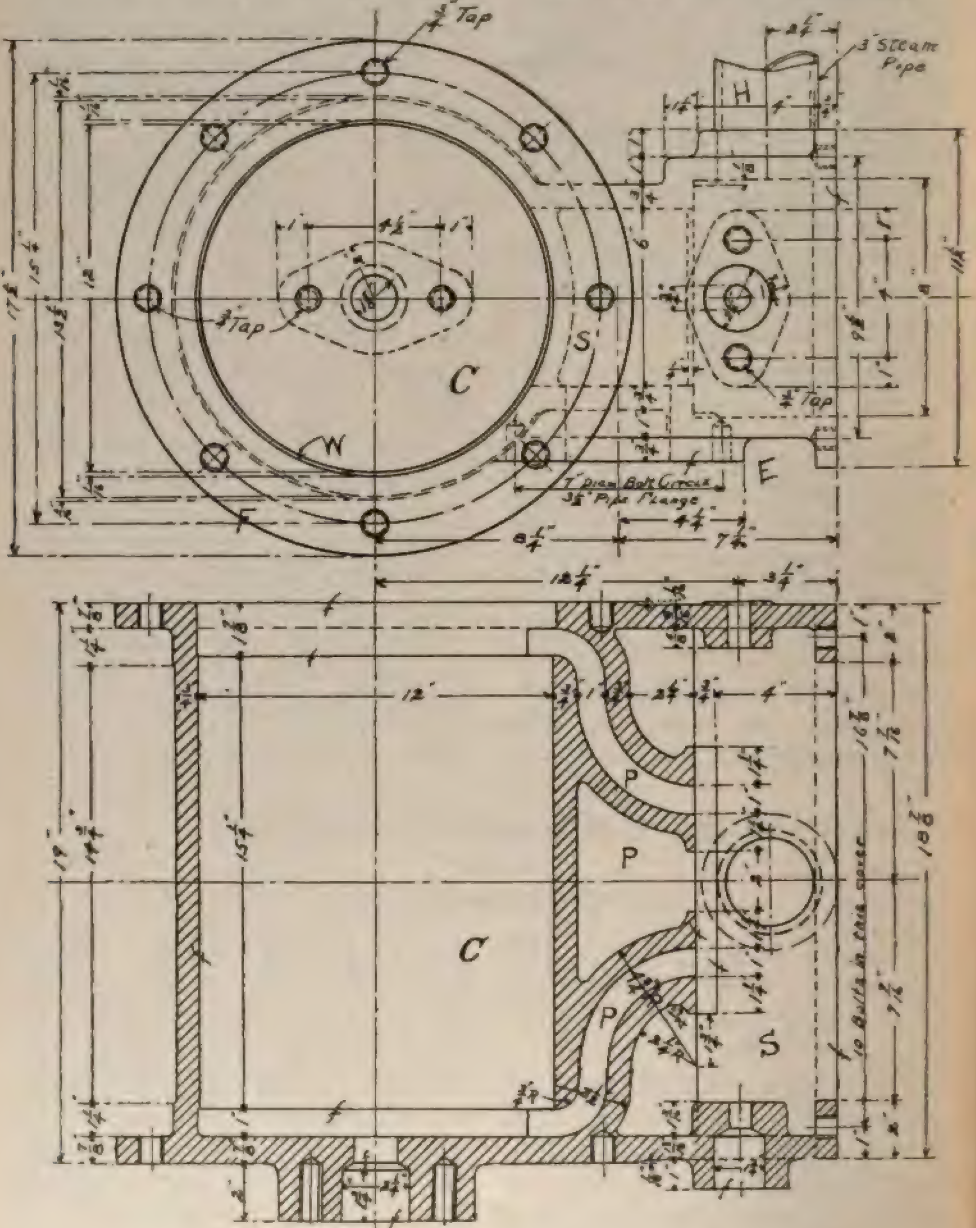
The work of this chapter will be the study of castings in general, and the drawing and calculation of a cast iron steam cylinder.

The accompanying sketch gives two views of such a cylinder. The lower view is a section through the center, and is shown hatched, since the metal is supposed to be cut. The upper view shows the end of the cylinder looking down upon it from above, and laid out according to the third angle method of projection. These two views are to be laid out as shown, and a third view is to be worked out showing the side of the cylinder looking into the steam chest. The best place to put this view is in the upper part of the plate and to the right of the end view. All the data necessary for this third view can be found on the two views given, but it will re-

quire some study to work it out.

A large part of a draftsman's time is occupied with such work as this. At first sight it may seem difficult to the learner, but he should bear in mind that it is only necessary to draw one line at a time. Take any line and observe its length and position on each of the views given, and then try to imagine how it will look in the view required.

For example, let the center line of



the third view be a continuation of the center line of the end view in the upper part of the plate. On this center line select a suitable point to represent the middle of the cylinder lengthwise; from this point lay off 9½" each way, and draw lines through the points so found perpendicular to the center line. These lines will represent the extreme ends of the cylinder, 19 inches apart, as shown on the sectional view given.

Continue in this way with all the other lines in turn.

The following are the names of the different parts of the cylinder referred to in the sketch. *C* is the barrel, *S* is the steam chest, *P P P* are the ports, *H* is the steam pipe, *Ex* the exhaust pipe, *W W* are the cylinder walls, and *FF* are the flanges.

In making this cylinder, a pattern of the outside, and a pattern of the inside, called a core box, has first to be made in wood. These wooden patterns then go to the foundry, where an impression is made of them in sand. This cavity in the sand is then filled with melted cast iron. After it cools off the casting is knocked out of the sand and cleaned up. It then goes to the machine shop, where it is bored out and fitted for use on the engine.

Nothing more than a brief outline of the process is attempted here. Reference books which treat the subject completely are given at the end of the chapter.

CALCULATION OF CYLINDERS

A cylinder will generally fail either by splitting the walls lengthwise or by breaking the cover.

The force which is operating to split the cylinder lengthwise is the pressure on the inside. It is assumed to act as shown by Fig. 1, where *a* is the diameter of the cylinder and the pressure is tending to break it at either end of *a*.

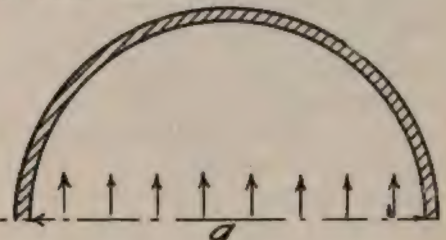


Fig. 1

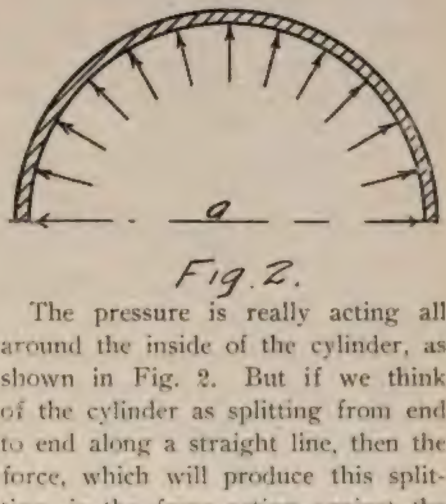


Fig. 2.

The pressure is really acting all around the inside of the cylinder, as shown in Fig. 2. But if we think of the cylinder as splitting from end to end along a straight line, then the force, which will produce this splitting, is the force acting against the projected area of either half as shown by Fig. 1. The force which will resist this stress is the area of the metal in the two walls of the cylinder, multiplied by the strength of the metal per square inch.

Let us suppose that the pressure acting on the inside of the cylinder is 100 pounds per square inch. The

cylinder is 10 inches in diameter and 20 inches long. Then the force which will produce rupture is 10x20x100=20,000 pounds (*a*).

The force which is resisting this is (supposing the safe tensile strength of cast iron to be 3,000 pounds per square inch) for the two walls, 20xtx2x3,000=120,000t (*b*).

If the cylinder does not break *a* and *b* must be equal, that is,
120,000t=20,000
t= .166" (a decimal).

This gives a result which has been found by experience to be entirely too thin for engine cylinders. Allowance is made for bad castings, for reboring cylinders and for possibility of the pressure being run up from any cause.

The following emperical formulas have been found to agree with practice:

(*a*) Whitman's formula $t=.03\sqrt{P.D.}$

(*b*) Van Buren's formula $t=.0001pd+.15\sqrt{d}$.

(*c*) Barr's formula t=.05d+.3".

t=the thickness of shell in inches.

D and d=diameter of shell in inches (inside).

P and p=pressure in pounds per square inch.

QUESTIONS.

1. Name and describe in not less than 200 words all the operations through which a casting may go from the foundry to the machine.

2. If a pattern weighs 10 pounds what will a casting made from it weigh?

3. Make a table showing the tensile and compressive strength of cast iron, wrought iron and steel.

4. Calculate the thickness of the cylinder on this plate for a pressure of 700 pounds per square inch.

5. Calculate the thickness of a wrought iron water pipe for a pressure of 150 pounds per square inch, using Formula (c) given in this chapter.

MECHANICS.

CHAPTER III.

Speed is the space passed over by a body in unit time. It has nothing to do with direction.

Velocity is speed in connection with which direction is also considered.

If the total space passed over by a body be divided by the time taken, the quotient will be the average space passed over by the body in one unit of time, and this is, therefore, the average velocity.

The fundamental formula connecting space, velocity and time, is

$$S=Vat. \quad (1)$$

in which *Va* is average velocity for the entire space *S*. For example, if a train takes four hours to go from one city to another, 100 miles distant, its average velocity is 25 miles per hour, although it may have had several different velocities on the journey.

Velocities are generally given in feet per second, or miles per hour. A convenient fact to remember is that a velocity of 60 miles per hour is equal to 88 feet per second.

Acceleration is the increase in

velocity per unit of time.

Suppose a ball to be placed upon a plane table and put in motion with a velocity of *A* feet per second; if there were no other forces, such as friction acting upon the ball it would continue moving at this rate forever. Let us suppose, however, that after it has been moving for one second we strike it and add *a* feet per second to its velocity and continue this at the end of each second; this increase in velocity is called acceleration. It is evident that at the end of one second the velocity of the ball will be *a* feet per second. At the end of two seconds it will be 2*a* feet per second, and at the end of *t* seconds it will be *at* feet per second. In ordinary examples of accelerated motion the force does not act at the end of each second, but acts continuously upon the body; in all cases, however, the acceleration is the total increase in velocity per unit of time. This gives us formula

$$V_1 = at \qquad (2)$$

in which V_1 is the instantaneous velocity of a body at the end of *t* seconds which is moving with an average acceleration of *a* feet per second.

Evidently, a body moving with an accelerated motion has a different velocity at each instant, and before we can find the space passed over by such a body we must get the average velocity for the entire distance. If the acceleration or increase in velocity is uniform the average velocity is equal to one-half the sum of the initial and final velocities; if the initial velocity is zero; that is, if the body starts from rest with an accelerated velocity, the average velocity is one-half the final velocity, or $\frac{1}{2}$ *at*, and consequently the space passed over in *t* seconds is obtained by substituting this value of Va in formula (1), giving

$$S = \tfrac{1}{2}at^2. \qquad (3)$$

If we consider equations (2) and (3) as simultaneous equations and eliminate *t* we get

$$V_1^2 = 2as \qquad (4)$$

If an accelerated body did not start with an initial velocity of *o*, but with a velocity of *u* formulæ (2), (3) and (4) become respectively—

$$V_1 = u + at. \qquad (5)$$

$$S = ut + \tfrac{1}{2}at^2. \qquad (6)$$

$$V_1^2 = u^2 + 2as. \qquad (7)$$

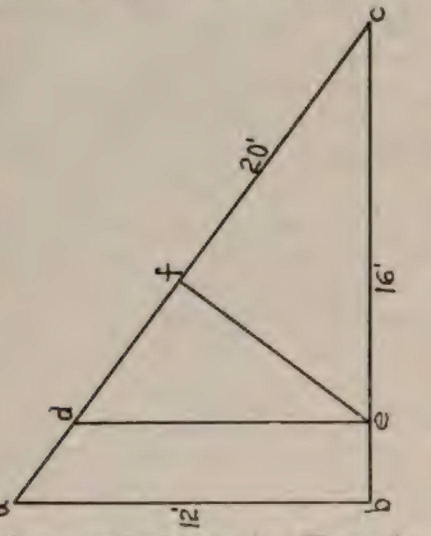
The working out of the last three formulæ is left as an exercise for the student.

Retardation is the opposite of Acceleration. It is the *decrease* in velocity in a unit of time. The formulæ for accelerated motion apply for retarded motion by taking into account the fact that retardation is negative acceleration.

The most common form of accelerated motion met with is that of falling bodies. When a body falls freely, there is the attraction of gravity acting continuously upon it, giving it an acceleration or constant increase in velocity. The approximate acceleration due to gravity is 32.16 feet per second.

A special case of falling bodies is that of a body moving down an inclined plane. Let *ac* be an inclined plane with the dimensions in feet as shown. Assume a ball to roll from *a*

to c without friction; draw de to represent to scale the attraction of gravity g, resolve this into two components, $d\ f$ parallel to the plane and



$e\ f$ perpendicular to it. Then the acceleration acting upon the ball as it rolls down the incline is represented to scale by $d\ f$, but triangle def is similar to triangle abc, therefore $\frac{df}{de}=\frac{ab}{ac}$ or $df=\frac{12}{20}$ of $32.16=\frac{3}{5}g$.

Then the velocity of the ball when it arrives at the point c is found by substituting in formula (4)

$$V_1^2=\frac{6}{5}g\ 20=24g$$

or

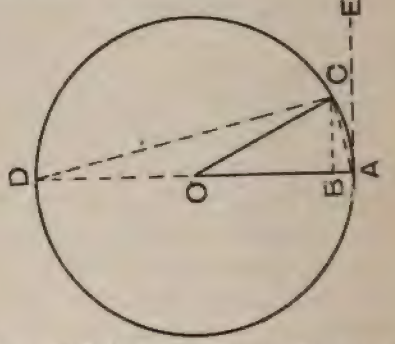
$$V_1=\sqrt{24g}$$

Now, suppose the body had fallen from a to b, the velocity at b would be found by substituting in the same formula, but the acceleration in this case would be g, then

$$V=\sqrt{2g12}=\sqrt{24g}.$$

Apparently, then, if friction is neglected the velocity attained by a body in going from one elevation down an inclined plane to a lower elevation is the same as that attained by a body in falling through the same difference in elevation.

Centrifugal Force.—Suppose a body to be revolving about the fixed point O with a *constant* velocity and let it be attached to the point O by a string $O\ A$; the body is then said to have a constrained motion.



Let AC be a very small arc of the path, then without sensible error the body can be considered to move from A to C along the chord instead of the arc. If the body were detached from the string at the point A, it would move along the tangent $A\ E$, but since it is not free to move along $A\ E$ it follows the path of the circle and in going from A to C it is drawn out of the path it tends to take by a distance AB.

Let the velocity of the body in the circular path be represented by V and let t= the time to go from A to C, and let R be the radius of the circle. Then from geometry $AC^2=AD\times A\ B$. Now $A\ C$, being the distance passed over by a body moving with a constant velocity, is equal to $V\ t$ and

$AD = 2R$, therefore, $AB = \frac{V^2t^2}{2R}$, but AB is the space passed over by a body moving with an accelerated motion and it is therefore equal to $\frac{1}{2}at^2$, then $\frac{1}{2}at^2 = \frac{V^2t^2}{2R}$, or $a = \frac{V^2}{R}$, that is the acceleration along the radius caused by the pull of the string is $\frac{V^2}{R}$; since elementary physics tells us that Force = Mass × acceleration, the force pulling on the string $= \frac{MV^2}{R}$. This outward pull on the string is called centrifugal force (C. F.)

Substituting W for M gives

$$CF = \frac{WV^2}{gR} \quad (8)$$

in which if W is in lbs., V and g in feet per second and R in feet $C. F.$ will be given in pounds.

Since $C. F.$ is used largely in mechanics, and since the velocity of revolving bodies is generally expressed in revolutions per minute (r. p. m.), we will derive another formula for such work. Let N be the r. p. m., then $\frac{2\pi RN}{60}$ is the velocity in feet per second, substitute this value in (8) gives

$$C. F. = .00034\ W\ R\ N. \quad (9)$$

Problems.

1. Niagara Falls is 164 feet high; how long does it take the water to fall over the falls, and what is the velocity attained at the bottom in miles per hour? Ans.—3.194 sec., 70 m. p. h.

2. A meteor falling vertically was observed to fall 1,608 feet during the 1-10 of a second preceding its striking the earth. How many miles high was it when it started to fall, considering it a freely falling body and having been acted upon by g=32.16 ft. per sec. during the entire distance? Ans.—761.5 miles.

3. A cannon is on a fort which is 40 feet above the surrounding plane, it is fired horizontally with an initial horizontal velocity of 1,300 feet per second, which velocity we will consider constant during the entire flight. How far did the ball go? Ans.—2,050.6 ft.

4. A car starts from the top of a slope 3,000 feet above the surrounding country, the length of the track from the top to the lower level is 30 miles, neglecting friction, how long will it take the car to arrive at the bottom, and what will be its velocity at the bottom? Ans.—12 min., 1.3 sec.; 299.46 m. p. h.

5. A skyrocket took 7 seconds from the time it left the ground until it returned; how high did it go? Ans.—196.98 feet.

6. A boy threw a stone into a window. The stone was in the air two seconds; how high was the window? Ans.—64.32 ft.

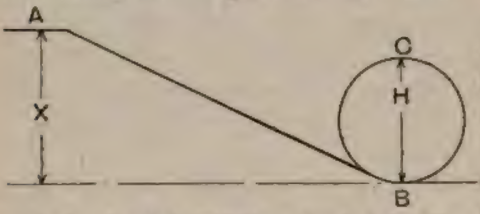
7. What must be the initial velocity given to a rifle ball to make it rise one mile in the air if fired directly upwards? Ans.—582.76 ft. per sec.

8. A body had been moving with a uniform velocity of 40 feet per second, it was then acted upon by a constant force which is capable of giving it an acceleration of 25 feet per second. What will be the velocity of the body after it has moved 96 feet under these new conditions? Ans.—80 ft. per sec.

9. In problem 8, how long did it take the body to move over the 96 feet,

and what was the average velocity for that time? Ans.—1.6 sec., 60 ft. per sec.

10. In a loop-the-loop machine a man with a bicycle starts from the platform at A, rides down the incline and develops speed enough to carry him around the loop at B. The man



and wheel weigh 200 lbs., the height H is 30 feet. What must be the lowest height X which could be used, neglecting friction? Ans.—125 ft.

11. A smooth glass inclined plane and ball were used to determine the value of g; the plane made an angle of 30° with the horizontal. The average of several trials gave the following result: When the ball was liberated at the top it passed over the first $10\frac{1}{4}$ feet in $1\frac{1}{2}$ seconds. What was the value of g? Ans.—32.39.

12. A train weighing 24 tons is running at the rate of 60 miles an hour on rails 4 feet apart; it rounds a curve of radius 3,000 feet: (a) What is the pressure on the flanges of the wheel if the rails are both the same level? (b) How much higher should the outer rail be in order that no pressure should be exerted upon the flange? (Consider no friction.)

Ans.—(a), 3,852.7 lbs., (b), 3.84+ inches.

In the matter of book publications Russia is at the foot of the list of nations.

A new explosive, which is called ammonal, has been made from powdered aluminum.

Cement is being used instead of wood for piles. They are made in triangular shape, and are driven in the same manner as those of wood.

To dock, scrape and paint one of the British ironclads costs an average of $20,000, and this has to be done twice a year.

Copper mines in Michigan have increased in number from less than 7,000 in 1893, to more than 14,000 in 1903.

Sunflowers make good fuel. The stalks when dry are as hard as maple-wood and make a good fire, and the seedheads, with the seeds in, are said to burn better than the best hard coal.

The great Corliss engine that furnished the power for the Centennial Exposition at Philadelphia had 300 horse power. At St. Louis one engine has 8,000 horse-power.

Greece is overrun by well educated men who do not know how to earn a living. The country swarms with doctors who have no patients and lawyers who have no briefs, while laborers to till the soil are at a premium.

CURRENT TOPICS.

Why Learn Drawing?

By D. Eldred Wood.

Few people realize what it means to possess a knowledge of drawing, and to be able to utilize that knowledge at pleasure. It has long been a belief among many people that one must have a natural ability in order been exploded by the introduction of to be able to draw. But this idea has drawing into the curriculum of study in the public schools all over the country. The progress which nearly all students make in the study of drawing in school shows conclusively that it can be learned, in just the same manner as music, geography, arithmetic, or writing. True, some students excel in drawing the same as in all other studies, but that does not of necessity prove that they have more natural ability for one study than another. It is usually because they devote more time to that particular study because they like it better than they do the others.

A knowledge of drawing is of more practical value to every one than almost any other line of study. For instance, if one wishes to explain to some one else, perhaps a foreigner, or some one who is unable to "catch the idea" as you see it, a few strokes of the pencil or pen, by way of illustration, makes it all clear. It is done in one-third the time and with much less effort than it would take to write it or explain the same thing in words. Drawing comes the nearest to being a universal language of any art at the present time, as people of all nationalities readily see the things expressed in drawings.

Then another thing, the person who can draw, even if he knows but a little about it, will see things all through life which otherwise would pass unnoticed. Why? Because people learn by seeing. The great majority of people have never been trained to properly see how a thing actually appears. This is the kind of training the study of drawing will give you. Did you ever write out a word to see how it looks, when you were a little uncertain just how to spell it? Somebody may tell you how a flower or tree looks, but you can't know so much about it as you can by "taking a look" at it. If you know *how to draw* you see more of the details and beauties with which everything in nature is surrounded.

We all think we know how a cat or dog looks, but few of us can make a drawing of either one. Our efforts would probably look about as much like one as the other, and the only way our friends would ever know what it was would be for us to mark it in plain letters "this is a cat" or "this is a dog." The reason why we

can't do this is not because of any lack of natural ability or talent, but because we have never noted the distinguishing features of a cat or a dog—never seen them as they really are.

We all know how our mother, father, sister or brother looks, but for the life of us we couldn't draw a picture which would be a recognizable likeness, because we never looked at them from an artist's standpoint, or with a thought of their distinguishing features.

And right here consider for a moment what an accomplishment it is to be able, when one is out in a company of friends, to sit down and draw a likeness of some one of them, or even draw pictures from memory or imagination. The whole company would be asking the privilege of watching you while you are at work. They marvel at the way expression is brought out, is changed from good to bad, sensible to senseless, from old age to youth, by the simple changing of a few lines, sometimes one very small one. They will stand for hours and watch a person draw and idolize him when he is through. By doing just a little practicing in this way the artist has no difficulty in becoming "the lion of the hour." He places himself in the front ranks of society, which ever stands ready to bow in humble submission at his feet. Why? Because they all know that while he may—while in their presence—put in the beauty lines in making a picture of them, he can, and just as easily, because he knows how, use others which will place them in an uncomfortable light, to say the least.

The artist becomes, as it were, a ruler of men. He wields a most powerful influence over people, and is a recognized factor in molding public opinion, even to shaping the destinies of nations, and the building of worlds.

Look at the great men in the field of commercial newspaper art today—such men as Fred Opper, John T. McCutcheion, George Busch, Davenport and Charles Dana Gibson. The late Hon. Marcus A. Hanna once said that there was only one man of whom he was afraid and that was Davenport, cartoonist for the New York Journal, because he said there was nothing he could do but "grin and bear" the caricature drawings which were made of him. We are all familiar with the society cartoons of Gibson and others, and anyone can at once realize what a potent factor these men are in picturing the national and international events of today and shaping men's minds in conformity with the policies of the "powers that be." It has also been said that political office-seekers dread the artists and illustrators as much, or more, than anything else, for if they have ever made a mistake in their lives it is sure to become known and then the "molehill" is changed into a "mountain" through the magic pen of the artist.

Such, then, are some of the possibilities before the person who can draw, to say nothing of the pleasure and satisfaction derived from presenting our friends with a piece of our own handiwork. We all know how much more a present is appreciated if it represents a certain amount of

our friend's own labor. We cherish it as a keepsake and when occasion offers usually find some way to return the kindness in the same manner.

And besides all this there are possibilities and opportunities for making those "delightful poetic transcriptions of nature." When one goes on a tour or travels into new or strange places, how many of us have wished, time after time, for the artist's ability—to reproduce, to save from total oblivion, except in memory, to preserve for future enjoyment, some tender and suggestive record of a judiciously selected landscape subject, an exquisite sunrise or sunset, a charming forest glen. Oh, for a general artistic equipment capable of rendering with dignified effect these picturesque effects. Such work, when brilliant in handling and elaborately finished without excess of labor, has an air of spontaneity which makes it extremely persuasive. And in no other way can one give expression to poetic ideas so vividly as by the art of drawing.

My young friends, learn to draw. It means more to you than anything else. Study the works of artists and draftsmen along the line of your inclination. Read the best publications devoted to the interest of those who wield the pen, crayon or brush. If you desire to follow some branch of art as an occupation, indeed as a profession, there is good money in it; there is plenty. The field is not crowded at the top, where you can certainly be if you have the true desire, the ambition and the aspiration to achieve.

Our Rapid Age.

Mr. Dwight L. Stoddard, in his *Steel Square Pocket Book,* says:

"A quarter of a century ago, although mechanics worked longer days than today, yet they seemed to have plenty of time to walk, or ride with an ox team to their work. And they thought they were going at a great speed if they rode in a car drawn by a mule. But today they must go at a breakneck speed on a bicycle, automobile, or as fast as electricity can carry them.

They used to work by the day. Now they work by the hour, and the time seems near when they will work by the minute, and every *minute* must count.

"Think of putting in a time card with 480 minutes for an eight-hour day. If one was late in the morning, say fifteen minutes, it would be deducted from the above.

"It would come to a point where the careful workman would soon acquire the habit of having his hammer in the air waiting for the first tone of the whistle, and if it was raised for a stroke when closing time came he would leave it there, that is, if the atmosphere was thick enough to hold it till morning.

"The draftsman would leave his pencil standing at a point against the scale and he would soon acquire the habit of not looking up from his work during the day. Alas! we regret that such a future is before us. It

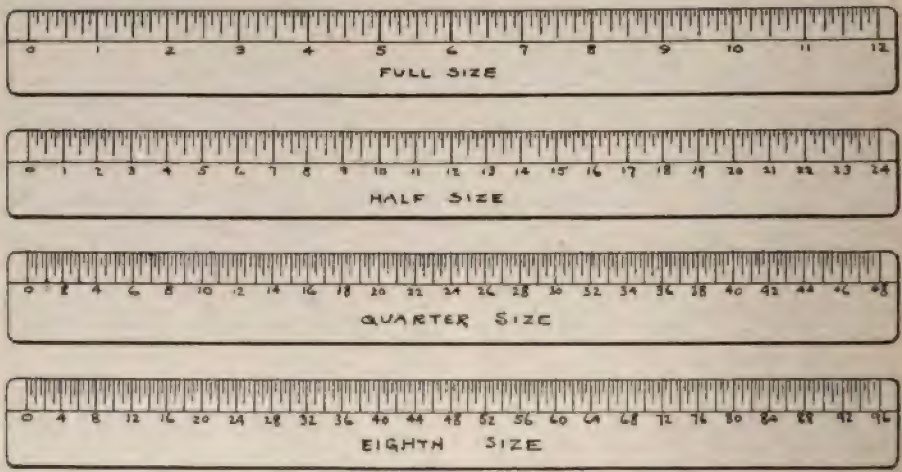
will no doubt make some of us old to think about it, or cause us to change to a climate where the sons of toil do not hustle quite so much."

Drawing Scales.

The subject of drawing scales has certainly had devoted to it its share of articles, but as every engineer and draftsman has ideas of his own about scales, I would like to express mine.

As sixty and seventy-two-inch rules, graduated in inches, have so universally taken the place of the old style two and three-foot rules, a drawing scale or set of scales to conform with same should be had. The architects' scale, as commonly used by mechanical draftsmen, was very good some time ago, when dimensions on drawings and sketches were in feet and inches, thus, 4'—7", but now, as it is more practicable to put same scale. With such a scale a draftsman would not have to calculate mentally what dimensions in inches corresponded to one in feet and inches and then change it back again when he places the dimension upon the drawing. Then comes the checker, who also would find the same convenience in an inch scale. Time now wasted in going over figures to be sure of them would be saved, and also fewer mistakes would be made.

Accompanying sketch shows cuts of scales which would be most common to mechanical draftsmen. I would suggest that the scales, four in number, full size, half size, quarter size and eighth size, would be separate and having one edge only graduated. They may be made either flat or triangular, as the draftsman deems best adapted for his work. The flat scales are very handy for reading dimensions from drawings or blue prints.



dimensions on in inches, thus, 55", it would be handier if a person had a scale graduated in inches the entire length of same, called a full divided but for accurate drawing a metal triangular scale is better because a prick point can be used to good advantage.—H. MacDonald.

A Letter.

Nephew Dan:

In reply to your letter relative to the drafting business, will now answer somewhat more at length.

You ask: First—What is the work like, or of what does it consist? Second—What should one's education be to insure success, or, more specifically, what studies should you pursue in the junior and senior years of your High School course?

To the first I will say in general that drafting is the written language of construction.

Drawings are of two general varieties—picture drawings, which belong more to the domain of the artistic, but show, in a general way, the appearance of the construction, and working drawings, which give all the information necessary to make whatever they are drawings of. It is this variety that the draftsman usually deals with, and it is his business to make them as clear, concise and complete as possible, artistic ability cutting but a small figure except in some classes of work, such as monumental work, art structural work, or decorative work of various kinds.

For instance, you wish a table made; you have a picture of a table just like you want it; you put some figures on the picture, giving the sizes of the parts and say what sort of wood, what sort of finish, etc., and it becomes a drawing, and when sent to the carpenter shows him just what you want made.

Suppose the one in charge gives you a rough sketch of a table, telling you how he wishes it to be made, gives you sizes, etc., and looks after your work from time to time. You make a drawing for it and might be called a draftsman, in so far as this particular case is concerned, but you are only a *copyist draftsman*.

Again, suppose a table is needed for some particular purpose. You make a drawing of a table to fit this purpose, taking into account size, material, method of putting together, what facilities the one who makes it has for doing the work, keeping uppermost in mind the purpose for which is it intended and not making it cost too much or yet be a poor job; taking hold of existing conditions, whatever they may be, and striking a happy mean whereby you accomplish the desired result in the best manner. You are now a designer, or at least a *designing draftsman*.

Any draftsman, to be of much value to a concern manufacturing anything or doing engineering, must be to some extent a designer. It is an easy matter to learn how to draw, but to know what to draw, i. e., have good ideas of how to make things, is not so easily learned and only comes to one by practical experience. In the case of the table: You may know about how large to make the various parts in order to have a good strong table, but if it were a bridge or a crane you were building, the parts would have to be calculated for

strength.

The draftsman usually starts in as a tracer, i. e., he inks in other people's drawings on transparent cloth, called tracing cloth. He thus learns how things are shown and "catches on" to many ideas about how things are made. As he advances, he makes drawings himself, mainly copied from other drawings with changes, and gets more ideas, and commences to work in ideas of his own.

When he has enough ideas of his own, so that he can take hold of a general scheme and get out the details in good shape, he is a draftsman. He may only be a detail man, but in some classes of work a good detailer is a pretty good man.

A draftsman is both a student and an instructor. He is always studying his work and the work of others, and is always instructing his fellows who have not studied or worked on what he has. The drafting room is necessarily a school of construction.

As to the education necessary. Few men in the business have the preliminary training they ought to have, and yet too much theory and too little practice are not looked upon favorably. A university course is not a necessity, but would be a very decided advantage. A good High School education would make a fair foundation upon which to build. Of the languages, German would come in handy, as many technical works not translated are written in that language, but is not essential. Mathematics and physics are the backbone of the constructive sciences. Calculus is seldom used in the drafting room, although it is used very much in the theory of mechanics. One can get along very well without it and do good work when they understand the ordinary geometric propositions and are able to solve a triangle.

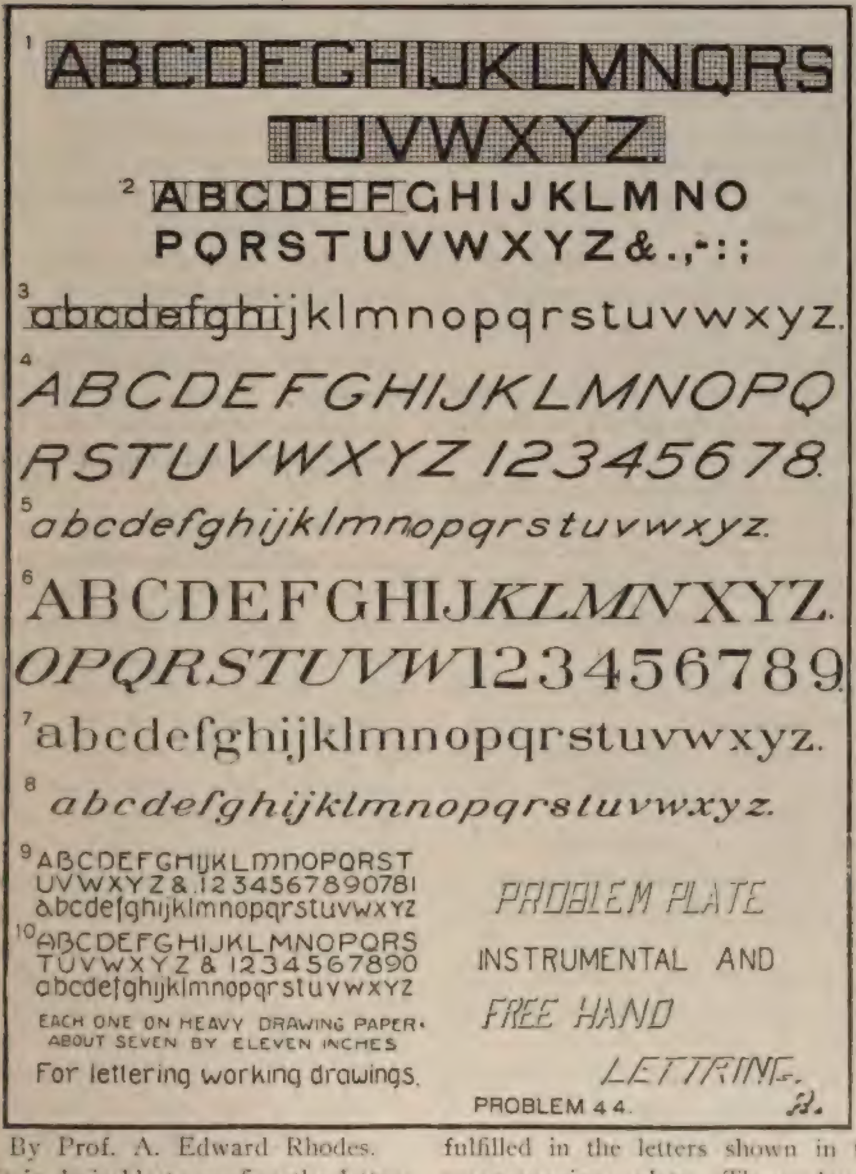
Of physics one should understand thoroughly all that is taught in the ordinary textbooks. The parts upon which it will be necessary to enlarge later will depend largely upon what line of drafting the student enters.

Draftsmen are one section of that large class who do something with their hands and brains for a livelihood. They employ their brain fat in developing constructions which add to our convenience, or safety, or are otherwise necessary or desirable. Latin, Greek, art, literature, fashion, society and politics are only side issues with them.

A doctor operates upon a patient for appendicitis when Rochelle salts would have been more to the point. The man dies. The doctor worked hard with him, but the man's time had come, so say the people. A lawyer defends an innocent man, but he is hung. Twelve good men, tried and true, found him guilty, so the people say it is so. The lawyer had a bad case, he did all he could. A minister may drive the young from the fold by preaching ten-yard faces, hell fire and brimstone, work in the vineyard, but take no amusement, and he is a zealous man. But let a structure fall and see how soon the engineer's reputation is blasted. He deals with the immutable laws of nature, be they known or unknown. And when failure occurs it is "up to him."

Your Uncle Jack.

Lettering.



By Prof. A. Edward Rhodes.

It is desirable to confine the lettering of drawings to one or two standard alphabets that are plain and distinct, and the principles of which are easily acquired. These conditions are fulfilled in the letters shown in the accompanying plate. These letters may be made free-hand or with instruments. Lettering is easily learned if the shape of the letters is first fixed in the mind of the student. This

is most readily done by comparing the various letters composing the lower case alphabet. (No. 3 on the plate.) The basis of the letters in this alphabet is a circle.

a is a circle with a vertical line added to its right side.

b is a circle with a vertical line added to its left side.

c is about three-fourths of a circle, open at the right side.

d is like *a* except that the vertical line is longer.

e is like *c* with the addition of a horizontal line across the interior.

f is like a cross with the addition of a small curve at the top.

g is *d* inverted. The lower end of this letter may be curved to the left as shown.

h is like *b* except that only the upper half of the circle is used and that the right end of the semi-circle is continued vertically to the guide line.

i is simply a vertical line with a dot above it.

j is about three-fourths as wide as the diameter of *a*.

k consists of three straight lines, the longest one a vertical, the others at 45 degrees with it.

l is simply a vertical line.

m consists of the upper halves of two tangent circles, and those vertical lines.

n is the left half of *m*, it also is like *h* with the top of the stem removed.

o is simply a circle. It is the basis of all the curved letters.

p is *b* inverted.

q is like *g*, excepting that the curve at the bottom is turned to the right.

r is the left half of *n*.

s consists of the upper and lower portions of the base circle, and of a reverse curve joining the left end of the upper with the right end of the lower portion.

t is *l* with a horizontal line three-fourths as long as the diameter of *a* and even with the top of the curved letters.

u is *n* inverted and reversed.

v is two lines meeting at their lower extremities and making equal angles with the horizon.

w is two v's placed side by side and touching at the top.

x is two lines inclined at forty-five degrees and intersecting at their middle points.

y has the right vertical line of *u* produced down and ending in a curve like *g*.

z consists of two horizontal lines, and an inclined line connecting them.

CAPITALS, OR UPPER CASE ALPHABET.

These letters and figures, like the lower case letters, are based upon the circle and are self-explanatory.

Beginners never can letter well, and it is necessary that they devote considerable time to practicing lettering before attempting to letter or dimension a drawing, for no matter how well the views may be drawn, if the lettering is poorly done the finished drawing will not have a neat appearance. No draftsman can letter as rapidly as he can do ordinary writing. Very frequently more time is spent in lettering a drawing than in inking in the views of the object represented. The importance of good lettering *cannot be over-estimated.*

Large letters, like those shown at 1, 2, 3, 4, 6 and 7, may be made with

the instruments. The small and inclined letters, like 5, 8, 9 and 10, are made free-hand, using first a round-pointed pencil and then an ordinary writing pen.

When making freehand letters *always* draw at least two horizontal guide lines, and if the least trouble is experienced in making the stems of letters parallel, draw guide lines for the stems. Great care should be exercised to get all horizontal lines horizontal, all vertical lines vertical and all inclined lines parallel.

The guide lines are for limiting the letter to its exact size, therefore, when a line should meet a guide line make it do so, but do not leave it project beyond the limiting guide line.

Blue Printing.

By Fred D. Foss.

Having received a letter from a prominent architect of Omaha, asking for a formula for making "blue print paper and instructions for developing the same," I will allow the intended continuation of the articles on hydrochinon development to lapse and comply with the request, giving several formulas for working the process, and also the formula in use by myself.

Perhaps a few preliminary remarks may lead to a clearer understanding of the action of light upon paper sensitized with iron salts, so as the result of Sir John Herschell's investigations will be given. "The double citrate of iron and ammonia is more readily acted upon by light than any of the other iron salts, the double oxalate of iron and potassium ranking next. (Printing with the latter has only an experimental value, so it will not be treated of in this article.) The law upon which the process of printing with salts of iron is based is that the ferric salts are by the action of light reduced to the ferrous salts, which are capable of being acted upon by various toning agents, such as potassium ferrocyanide, chloride of gold, platinic tetrachloride, mercuric chloride, potassic bichromate, cupric chloride, and others. The developing solution most commonly employed is potassic ferrocyanide, and for its use two methods are adopted, one being to coat well-sized paper with the solution of the iron salt, dry, print, and tone on a solution of potassic ferrocyanide. The other and more convenient method is to coat the paper with a mixed solution of iron and ferrocyanide, and to fix the print in water. Should the first method be chosen, the following way may be adopted:

Citrate of iron and ammonia......
.... 154 grains
Water (distilled) ....25 drams

Apply this solution to the paper with a brush or sponge, or float the paper on it from one to three minutes. When dry, expose under the negative until a faint image is visible. For a blue print, immerse in a solution of potassium ferrocyanide one to ten (potassium ferrocyanide one ounce, water ten ounces). When the image is fully developed or toned, wash thoroughly in water, adding a little citric or acetic acid to the first wash water. This will dissolve out all the soluble salts and leave the blue

image unchangeable. If a purple image is desired, immerse the print in a neutral solution of chloride of gold (gold, 1 grain; water, 4 ounces; to which is added a few drops of saturated solution of bicarbonate of soda). The reduction of the gold takes place according to the law that the ferrous salts reduce salts of gold to the metallic state. To fix the pictures, they are immersed in a bath of dilute hydrochloric acid and then thoroughly washed in water. This process gives the once famous chrysotype. Other tones may be produced by immersing the prints in a very dilute solution of platinic tetrachloride, mercuric chloride, cupic chloride, or potassic bichromate of about the same strength as the gold solution mentioned above, always using the acid bath, followed by copious washing. These methods give very pleasant results and are worthy the attention of architects who desire to reproduce their plans or drawings. Pure chemicals, water and paper should be used if permanency of prints and good results are desired. Longer exposure will be found necessary with the salts of gold, platinum, etc., than when the ferrocyanide is employed. An interesting method of developing prints for paper prepared with the double salt of iron and ammonia is to float on a forty-grain solution of silver nitrate, to which a few drops of gallic acid or acetic acid have been added. The silver nitrate is reduced to the metallic state by the ferrous salt, and the metallic silver is deposited where the ferrous salt was present. The gallic acid causes a further reduction of silver, and an image in metallic silver is formed, which is presumably permanent. We now come to the more usual method of using the citrate of iron in conjunction with the ferrocyanide, thus uniting sensitizer and developer. This process has simplicity to recommend it, and when at its best gives very charming results. But to insure the highest degree of excellence in blue prints, the following points must be carefully attended to:

1. The chemicals should be of the best.

2. The paper must be free from deleterious matter.

3. A few grains of bromide of potassium should be added to the mixed solutions to confer greater keeping, however, to the paper and to add to the density of the prints.

4. The first wash water should contain a little citric or hydrochloric acid, and the after washings in plain water should be most thorough.

5. The paper must be sensitized in a dim light—gaslight is safe—or pure whites will be unknown.

6. The paper should be sized. Albumen coagulated by heat is undoubtedly the best sizing, but the following arrowroot sizing will be found good: 154 grains of arrowroot rubbed up with cold water, then poured into 25 ounces of boiling water, and 6 ounces of alcohol added. Float the paper on this solution for two or three minutes, and suspend to dry by the end which left the solution last, in order to equalize the coating. Plain sized paper can, however, be purchased from Douglass' photographic stock house, which will answer all purposes. Good blue prints

can be made without attention to these details, but all the capabilities of the process will show themselves only when they are observed, and bear in mind the old maxim: "What is worth doing is worth doing well."—Inland Architect.

According to La Nature a new compound of water, albumen, sulphate of magnesia, alum, sulphate of Calcium, roasted, and borax, the mixture being called calxia, is destined to displace terra cotta and plaster in the majority of their uses, especially in making small articles and covering small surfaces. The advantages claimed for the new substance include lightness and power of resisting shocks which would break terra cotta. It also has a very high degree of imperviousness to hot and caustic solutions. Finally, according to La Nature, the process of manufacture can be carried out by anyone, though there must be care to make it exactly correct, and the cost is only about half as great as that of terra cotta.

A Trade Prophet.

The remarkable manner in which the trade conditions, which have prevailed thus far during the present year, were foretold last December by Samuel Benner, a farmer of Dundas, O., has created a great deal of comment among the manufacturers of the country, particularly the steel men, who have for many years given much weight to the prophecies made by the Buckeye farmer sage.

For many years Benner has been announcing, a year ahead of time, the trend of trade, basing his prediction on the proposition that periods of finance and trade move in cycles and that, having once learned from the history of the past the duration of the cycles, it was the easiest matter to foretell the probable course trade and finance would pursue in the future. He covers the conditions of steel, iron, grain and provisions, and has been so remarkably successful that the steel men watch the predictions with great care.

Benner lays no claim whatever to supernatural power, basing his predictions solely on the lessons of the past. The late Addison Cammack, one of the greatest speculative traders in the history of Wall street, watched the predictions for many years and during the later years of his activity in the market was guided solely in his transactions by the predictions of the old man. During the early 90's it was the prediction of Benner that a cycle of high prices had come that induced Cammack to undertake his campaign which netted him over $1,000,000. He believed Benner had gained a foresight into the economic laws governing the world of trade.

Last December, when Benner gave out his predictions for the present and the coming year, he gave a forecast of what has happened in a most complete manner, so much so that the predictions have been reprinted and are in circulation among the traders of Wall street, who are following them more than most of them care to ad- Benner predictions are as follows:

"I predict that prices for pig iron, railroad stocks and many commodities will be lower in 1904 than in 1903.

"I predict that after the year 1904 there will be a revival in trade, better times, and that higher prices will prevail until the year 1911.

"The present down cycle in prices and in general business ends in 1904, and by reason of a protective tariff this country has not had an old-fashioned period of hard times during the past three years. Nevertheless, there has been a stupendous fall in prices and shrinkage in values of railroad and industrial securities with a severe decline in iron.

"The year 1905 will be the beginning year of a new up cycle in pig iron and long continued prosperity in general business, lasting until the next commercial revulsion, which will be due in 1911.

"When our financial and commercial depressions reach their lowest limits, as determined by the cycles in trade, they afford the best opportunities to make profitable investments of money in property, in railroad stocks, in industrial securities, in manufactures and in mercantile pursuits.

"Looking forward beyond the year 1904 the cycles indicate six years of national prosperity.

"The coming opportunity to catch business and prices at their lowest limits of depression will not happen again for twenty years.

"The prospects of a bright business future were never better for moderate and continued prosperity, but no great boom in prices similar to earlier times when we had $50 pig iron."

Good Law=Common Sense.

In the strike of the building trades in New York City, a striker was arrested who had beaten a workman because he would not leave the wagon he was driving for a lumber company. The striker was arrested and brought before Magistrate Crane, who held him in $500 bail for trial. In doing this, Mr. Crane told the prisoner some home truths. "I want you and every other man to understand," said he, "that it is the right of every one to work or not, as he or she sees fit, and to accept such wages and work such hours and for such employers as they like. In that right they are entitled to protection, which I will give them every time. If this man's work suits him, it is none of your or anybody's business to interfere." This is not only sound common sense, but it is good law. As soon as courts do their duty, and treat lawless labor union men in exactly the same way as other law-breakers are treated, the use of violence in connection with strikes will become a thing of the past.

The Value of the Fingers.

In the early fall all over the world during the beginning of the winter musical and theatrical season a peculiar and large line of business is carried on in a certain channel of life insurance, of which the general public have little or no knowledge whatever. By some underwriters it is termed "freak insurance," and interests principally famous and nota-

ble celebrities in the musical and theatrical fields, although this special line of insurance has included costly trained animals used for show purposes.

No less a personage than the celebrated Mme. Patti was one of the criginators of this extraordinary kind of insurance. Her gifted voice, which has been heard all over the world, and which is the most intangible of subjects, is insured for $5,000, on which she pays a premium of $125 a performance.

Paderewski, of international reputation, has his hands underwritten for $50,000, and for each of his concerts, a temporary policy is taken out for $7,500. He considers his hands more precious and valuable to him than any other member of his body, for in the loss of them he would be deprived of the means of revealing his soulful music and making his livelihood.

Josef Hofmann, not less famous on both continents, advocates most strongly this kind of insurance, as he goes further into the financial end of it, as can be readily seen, when it is known that he has set a price of $500 on each finger of both hands.

Think of it. Placing the sum of $50,000 on the fingers of your hands! As a matter of fact, Hofmann has placed more insurance on his fingers than on his life. And the same statement holds good for the vast majority of those who insure at a large figure some particular portion of their anatomy.

As a precaution against accident in preventing him to open his performance, Kubelik, the famous musician, has had his right hand insured for $10,000 for each concert, and for $50,000 against total disablement.

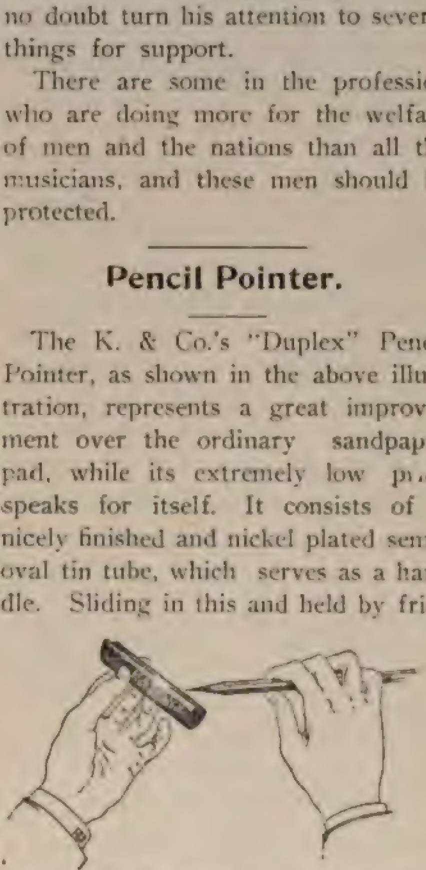
What could a draftsman do if he lost his fingers?

He is fortunate enough to know more than mere drafting and could no doubt turn his attention to several things for support.

There are some in the profession who are doing more for the welfare of men and the nations than all the musicians, and these men should be protected.

Pencil Pointer.

The K. & Co.'s "Duplex" Pencil Pointer, as shown in the above illustration, represents a great improvement over the ordinary sandpaper pad, while its extremely low price speaks for itself. It consists of a nicely finished and nickel plated semi-oval tin tube, which serves as a handle. Sliding in this and held by fric-



tion is a V-shaped spring mounted with a piece of emery cloth, which serves as abrading surface. A circular channel at the bent of this spring serves as a receptacle for the lead filings, whence they can be easily shaken out without soiling the hands.

To sharpen a pencil press the point slightly into the groove formed by

the spring and draw it lengthwise from end to end, holding it steady when a flat point is required, and rotating it for a round point. The spring will adjust itself automatically to the proper contact and, owing to the curved abrading surface, a perfect point is obtained.

The emery cloth will last for months. If worn out it can be easily renewed by removing the spring, in which a new sheet is inserted, whereupon it is replaced in the handle.

The K & Co.'s "Duplex" Pencil Pointer, on account of its perfection, simplicity, durability and moderate price, recommends itself to every draftsman, engineer, etc.

Kolesch & Co., New York.

Book Notices.

Architectural Drawing Plates. Folio One. Price, 75 Cents. Details of Construction. Published by The Taylor-Holden Co., Springfield, Mass.

A series of 10 plates, 8x11 inches, arranged for classes in Architectural Drawing, by Frank E. Mathewson, author "Notes for Mechanical Drawing." A limited edition will be ready November 1, 1904. Applications for Folio One filled in order in which they are received. Folios Two and Three in preparation.

"Gasoline Vehicle Management," excellent for its completeness and "useful hints;" another on gasoline cycles that covers the general principles involved in this type of motor.

An exceedingly full index at the close of the book puts its contents into "ready reference" shape, an advantage of no small importance in view of contingencies sometimes happening in the use of the 'mobile.

"The Steel Square Pocket Book," by Dwight L. Stoddard. Published by The Industrial Publication Co., 16 Thomas St., New York City. Price, 50 Cents.

This little book is intended to give short, concise rules and examples of the use of the carpenter's steel square. The aim of the author is to tell all that can be done with the square in the laying out of framing of all kinds, including circular, octagon and square roofs, bicycle tracks, kerfing boards for circle, pipes through roofs, and many other hard problems.

There are 100 pages, with more than an illustration to the page, all on good paper and with clear type, bound in cloth, board backs.

They Ought To.

"How's you gettin' on wid youah 'rithmetic, Lou?"

"I done learned to add up de oughts, but de figgers bodder me."—Collier's.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Specifications for Marine Engines.

By Carl H. Clark.

The following specifications are intended to serve as a guide in getting out specifications, by bringing to notice the important items and serving as a general outline.

While the specifications as below refer to the triple expansion engine, they may, by suitable changes, apply to any other type.

Engine to be of the three-cylinder, vertical, direct acting type, with cylinders as follows:

H. P. ——— inches diameter.
I. P. ——— inches diameter.
L. P. ——— inches diameter.

with a common stroke of —— inches, designed for a working steam pressure of —— lbs. per sq. in., and to develop about —— I. H. P. at —— turns per minute.

CYLINDERS.—To be arranged in the order of H. P., I. P., L. P., with the L. P. cylinder aft, with receivers between. Cylinders to be of hard, close grained iron, as hard as allowable for proper machining. All ports and passages to be of ample size to allow a free passage of steam. Cylinders to be counterbored top and bottom to allow overtravel of steam rings.

H. P. Cylinder to be —— inches in diameter. Walls to be —— inch thick, and fitted with a hard iron liner —— inch thick, securely fastened in place. To be fitted with a piston valve —— inches in diameter. Valve liners to be —— inch thick, of hard iron. To have a passage leading around cylinder, from H. P. to L. P. steam chests.

I. P. Cylinder. To be —— inches in diameter, walls to be —— inches thick. To be fitted either with a piston valve —— inches in diameter and valve liners —— inches thick, or with a double ported slide valve with separate hard iron valve seat —— inch thick, held in place by composition tap bolts. Slide valve to be fitted with a balance piston.

To have a passage leading around the cylinder from I. P. to L. P. steam chests.

L. P. Cylinder. To be —— inches in diameter. Walls to be —— inches thick. To be fitted with double ported slide valve. Valve seat to be separate,

of hard cast iron —— inches thick, fastened in place with composition tap bolts. Slide valve to be fitted with balance piston.

Cylinder bottoms to be....inch thick, and strongly ribbed. Cylinders to have suitable flanges for bolting together; and for securing to columns Drain cocks to be fitted to the bottoms of cylinders and valve chests, piped to condenser and bilge and arranged to be operated from the working platform. Relief valves to be fitted to cylinders and valve chests. All stuffing boxes for piston rods and valve stems to be fitted with approved metallic packing. Indicator cocks and piping to be fitted to each cylinder. Cylinders and valve chests to be covered with non-conducting material and lagged with Russia iron, or polished hard wood. A passover valve to be fitted between H. P. and I. P. steam chests with handle leading to working platform.

CYLINDER HEADS—To be of cast iron......inch thick, well ribbed and covered with polished plates. To be well bolted to cylinders and fitted with lifting eyes and starting screws.

PISTONS—To be of cast iron, hollow box type...... inches deep, well webbed, or of cast steel, conical type of sufficient depth to give good strength. To be fitted with...... suitable rings......inch thick and ......inches wide. Follower to be secured with steel bolts and brass nuts.

PISTON RODS—To be of mild steel......inches diameter in body of rod, to have shoulder under piston, and taper fit to both piston and rod. To have a nut on each end, held in place by approved locking device.

CROSSHEADS—To be of forged or cast steel either the slipper type or box type and to have a go-ahead bearing surface......inches long and ......inches wide, surfaces to have removable shoes lined with lining metal held in place by dovetailing To be fitted with double wrist-pins each......long and......inches diameter.

GUIDES—To be suited to crosshead, to be securely bolted to back columns and arranged for water circulation.

CONNECTING RODS—Of forged steel......inches in diameter at neck and......inches diameter at lower end. Upper end forked with double wrist-pin bearings each...... inches long and......inches diameter, with composition boxes. Rods to be......inches between centers. Lower end to have tee end to fit box. Crank-pin box to be of bronze lined with white metal, bearing to be......inches long and...... inches diameter. Bolts in upper end to be......inches diameter, and those in lower end to be......inches diameter; nuts to have approved device to prevent loosening.

VALVES AND VALVE GEAR—*Valves* to be of hard cast iron. H. P. piston valve to be......inches in diameter, taking steam at...... I. P. piston valve......inches in diameter, taking steam at....... Steam rings to be of cast iron and removable. Slide valves to be of double ported type, accurately fitted to valve seats. Travel of valves to be......inches. Valves to be secured to stem by com-

position nuts and washers.

VALVE STEMS—To be forged steel......inches in diameter. To be efficiently guided by composition slides with large bearing surfaces.

LINK MOTION—Of the double bar Stephenson link type, operated both by steam and hand gear and fitted with gag to vary the cut-off.

LINK BLOCK—Of forged steel, with composition sliding shoes.

ECCENTRICS—Of cast iron..... inches face and......inches diameter in halves, set-screwed and keyed to shaft.

ECCENTRIC STRAPS—Of cast iron, lined with white metal and fitted to take the stub ends of rods.

ECCENTRIC RODS—Of forged steel......inches diameter. Upper ends forked for bearings, for connection to link block. Lower end to have tee connection to eccentric straps.

BED PLATE—To be of cast iron, box or girder shape, and strongly webbed. To be at least......inches deep under main bearings and to have all necessary flanges for holding-down bolts, columns, etc. Journal boxes to be of composition, two for each cylinder. Bearings to be...... inches in diameter and......inches long, lined with best anti-friction metal, held in place by dove-tails. Main bearing bolts to be......inches in diameter, nut to be provided with device to prevent unscrewing. Bed to be in......pieces, held together by ......inch fitted bolts.

(If condenser is built into back frame, bed plate to have suitable flanges for bolting to condenser.)

FRAMING—Front columns to be of wrought iron....to each cylinder, turned and finished......inches in diameter, with flanges at each end for bolting to cylinders and bed. Back columns to be of cast iron, box section, one to each cylinder, to have suitable flanges for bolting to bed plate and cylinders, and fitted with lugs to support the main guides. (If condenser is built in, back columns are to rest on condenser.)

CRANKSHAFT—To be of the built up type, of the very best mild steel, in three sections, all interchangeable. Shaft to be......inches in diameter. Crank pins to be...... inches diameter and......inches long. Slabs to be......inches wide and ......inches thick, securely shrunk and keyed together. Coupling flanges to be forged on, and to be......inches diameter and.....inches thick. Couplings to have......bolts in each, ...inches in diameter.

SHAFTING—

Thrust Shaft—To be......inches diameter of very best forged steel with......collars. Collars to be..... inches in diameter, ...inches thick, with......inch space between collars. To be fitted with forged couplings ......inches in diameter and.....inches thick, fitted with..... bolts......inches diameter.

Turned Shafting—To be best steel ......inches in diameter, rough turned, except at steady bearings. Couplings to be forged on, to be...... inches diameter and.....inches thick, fitted with......bolts......inches diameter. Steady bearings to be arranged every......feet.

Tail Shaft—To be of best steel ......inches in diameter, with forged coupling at inner end to correspond

with the line shafting. Outer end to have taper and key to fit propeller, with nut and keeper outside. To have composition sleeve shrunk on at stuffing box and at stern bearing and between them to be covered with a continuous brass tube made watertight.

THRUST BEARING—To be of the box type with......adjustable horseshoe collars, lined with white metal and properly channeled. Side rods to be of steel......inches in diameter and provided with nuts for adjusting the horseshoes. A steady bearing is to be provided at each end, and the collars to run in oil.

STEADY BEARINGS—To be fitted wherever necessary; of cast iron, lined with white metal.

REVERSING GEAR—To consist of steam cylinder......inches diameter and......inches stroke fitted to one of the back columns. Valve to be controlled by floating lever from working platform. Rock shaft to be ......inches diameter carried in bearings on back columns.

TURNING GEAR—To consist of a cast iron worm and wheel, driven by an engine......inch diameter of cylinder and......inches stroke (or by a ratchet and lever). Worm is to be so arranged as to be easily thrown in and out of gear.

STERN TUBE—To be of cast iron....thick in the body; inner end to have large flange securely bolted to after bulkhead, outer end to be secured to stern post by proper nut on the outside. Tube to be sufficiently supported by framing. Outer bearing to be......inches long and to consist of a composition bush filled with end wood lignum vitæ; inner bearing to be lined with lignum vitæ and fitted with strapping box at inner end.

PROPELLER — Diameter...... feet. Pitch......feet. Expanded area......square feet, to be of sectional type with......blades. Each blade to be bolted to hub with......bolts......inch diameter. Blades to be of......and hub of cast iron. Hub to be bored and carefully fitted to taper of tail shaft. Nut on end of shaft to be covered by a fair water cap bolted on.

PIPING—All steam piping to be of copper, of proper gauges, with brazed flanges, properly bolted together, and must conform to the U. S. Inspection laws. Water piping of brass and galvanized iron. Valves smaller than 2½ inches to be all brass, those above 2½ inches to have cast iron bodies and brass seats and stems. Plugs and cocks to be arranged to drain all parts of the piping system. All steam piping to be covered with approved magnesia covering. Main stop-valve to be a balanced valve with an opening not less than......inches in diameter. Body of cast iron, and valve, seat and stem of composition. To be worked from working platform.

Bilge piping to be of lead, leading to suitable manifolds in engine room and strainers in bilge. All places where moisture can collect to be properly drained.

CONDENSER—To be a surface condenser having......sq. ft. of cooling surface. Shell to be of cast iron or wrought iron, well provided with hand holes. Tubes to be......inches outside diameter of brass. Tube plates to be......inches thick fitted with screw glands, ... supporting

plates......inch thick, also to be fitted between tube plates. Shell to be provided with suitable flanges for exhaust and air pump suction. Also soda-cock and salt water feed.

Heads to be of cast iron, bolted to flanges of shell, and to be provided with nozzles, for bolting on circulating pipes.

(If condenser is made a part of the back framing, it must be well ribbed and be provided with proper flanges for bolting to bed plate and back columns.)

LUBRICATION—All bearings to be properly lubricated. Main journals to be fitted with composition oil boxes with a tube for wick feed. Slides, crossheads and crank-pins to have suitable sight feed oil cups fastened to cylinder casings, with leads of copper tube to each journal. Eccentric straps to have oil boxes fastened on the side of the eccentric rods with copper tube leading to the bearing surface. Link gear to be fitted with oil cups.

WATER SERVICE—A complete water service to be fitted to all main bearings, guides, thrust bearings and spring bearings.

LIFTING GEAR—To be fitted for lifting cylinder heads, condenser doors, thrust blocks, and all heavy parts of the machinery.

HANDLING GEAR — At the working platform there will be the following hand gear:

Reversing lever.

Throttle valve lever.

Drain cock lever.

Pass-over valve.

PLATFORMS, LADDERS, ETC. —Engine room floor to be composed of iron plates, well fitted; upper grating to be arranged near the tops of the cylinders, and middle grating at a suitable height for handling the crossheads, stuffing boxes, etc. Ladders to be arranged wherever necessary to reach the various platforms and parts of machinery.

SEA VALVES—To be of suitable design and to consist of the following:

Main injection.

Outboard discharge.

Blow-off.

Bilge discharge.

Air pump discharge.

INDICATOR GEAR — Complete indicator gear with reducing motion to be fitted to each cylinder.

STEAM GAUGES AND FITTINGS—Gauges, etc., to be furnished and fitted in place near working platform; main steam gauge, one gauge for each receiver, vacuum gauge, counter and clock, all of brass, having......inch faces, and neatly mounted on polished hard wood board.

WRENCHES—A full set of working wrenches of polished steel, to be furnished for all parts of the engine, with a rack for same located in engine room.

PUMPS—Circulating pump to be of centrifugal type, driven by an independent engine, with cylinder.... inches diameter and......inches stroke. Pump wheel to be...... inches in diameter of composition; shaft to be brass covered. Suction and discharge pipes to be of copper ......inches diameter.

AIR PUMP—To be independent direct acting:

Air cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

FEED PUMP—To be of duplex type:

Water cylinder......inches diameter.

Steam cylinders......inches diameter.

Stroke......inches.

DONKEY PUMP—To be of duplex type:

Water cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

BILGE PUMP—To be of Duplex type:

Water cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

WATER SERVICE PUMP—To be of Duplex type:

Water cylinders......inches diameter.

Steam cylinders......inches diameter.

Stroke......inches.

INJECTOR—Of ample size to be fitted.

SPARE PARTS—The following spare parts to be furnished:

1 main piston rod.
1 set steam rings for each piston.
12 follower bolts.
1 crank-pin brass complete.
1 crosshead brass complete.
1 main bearing brass complete.
2 crank-pin bolts.
2 cross-head bolts.
2 main bearing bolts.
1 set coupling bolts and nuts complete.
1 crank-shaft.
1 eccentric strap.
1 main valve stem.
1 piston rod for each pump.
1 complete set of valves for each pump.
25 condenser tubes.
1 spring for each relief valve.
1 spare propeller.
1 spare tail shaft.
1 set piston rod packing.
1 set valve stem packing.

All materials used must be best suited to the use to which they are to be put. All castings must be sound and free from blow-holes. All permanently fixed parts must be fastened with fitted bolts, reamed in place. All parts to be readily accessible without disturbing any other part. All workmanship to be of the very best and any portion found defective must be replaced. All necessary wrenches, oil cans and engineers tools to be furnished.

GENERAL.—It is the purpose and intent of these spicifications to furnish an ottfit first class in every Rrespect, and any part not mentioned in these specifications, but necessary to complete the work is to be furnished and fitted without charge.

How Big Clocks Are Made.

The providing of correct time for the world is an important industry. The making of big clocks is one of the features of it. In illustration of this the city of Toronto, Canada, has just completed a clock alongside of which men look like babies. It has a diameter of twenty feet. Its minute hand is twelve feet long, while the hour hand is five feet in length.

The numbers on the face of the clock have a height of two feet and nine inches, and the minute strokes are six inches in length. In performing its daily task of indicating the time, the long hand of this clock travels a quarter of a mile, or ninety-one and a quarter miles a year.

The first thought in the making of a big clock is the weather conditions under which it will have to perform the duty required of it. The hands of the Toronto clock do their work at an elevation of 250 feet, and whether it rains or snows, complete their daily round without resting. But without hands especially built to resist it, a Canadian snow storm would do surprising things, even to twisting and breaking them off.

Where clocks have to work under such weather conditions as the Toronto timepiece does, the hands are made elliptical, in the shape of double sheets of copper, convexed toward the center and strongly riveted every four inches of their length. After the dial was planned, the templet from which the mold was made had to be cut, and the great dial was cast wholly in iron.

The huge frame which contains the intricate and delicate mechanism of the works was also cast in one piece. Remembering that the clock is exposed to the changing conditions of the weather and the influences of these conditions on metal, the necessity of dispensing with nuts, screws and bolts becomes apparent.

Big clock dials vary from eighteen to sixty feet in circumference, and the dial room at a maker of tower clocks is an interesting sight. There are dials of iron in various stages of completion everywhere. They are being painted, glazed and gilded. Those intended to serve in illuminated clocks are glazed with opal glass, as this, better than any other, diffuses the light equally over the surface of the dial. The dial of the Toronto clock weighs about four tons, or 8,000 pounds.

No tower clock like that of Toronto is complete without its bells, and the making of these bells requires much judgment and skill. There must, of course, be the proper proportions of tin and copper, the scientific mixing of them in the furnace, and the exact moment must be known to run the metal into the mould, after the cores from which the bells are shaped have been built up and dried.

Then there is the tuning of the bells. To tune a bell is declared to be a most difficult business, because when struck it sounds a trio of notes instead of one. Consequently it requires an expert ear to catch the dominant note. By a special machine invented by the firm which constructed the Toronto

clock, this difficulty has been overcome, and the operation of tuning much simplified.

The bell is inverted. It is held stationary by powerful grips, the steel cutters for paring the metal to secure the required notes being in the interior. These cutters are revolved by machinery, and shave the metal as easily as a plane shaves a plank. In this manner the bell is toned either up or down, as desired, till the correct note is secured.

From this it will be seen that the building of a big clock is no light labor. It requires the skill and cunning of scores of hands, and they must see that it gives correct time to the thousands who daily look up to it.

Professor Unwin.

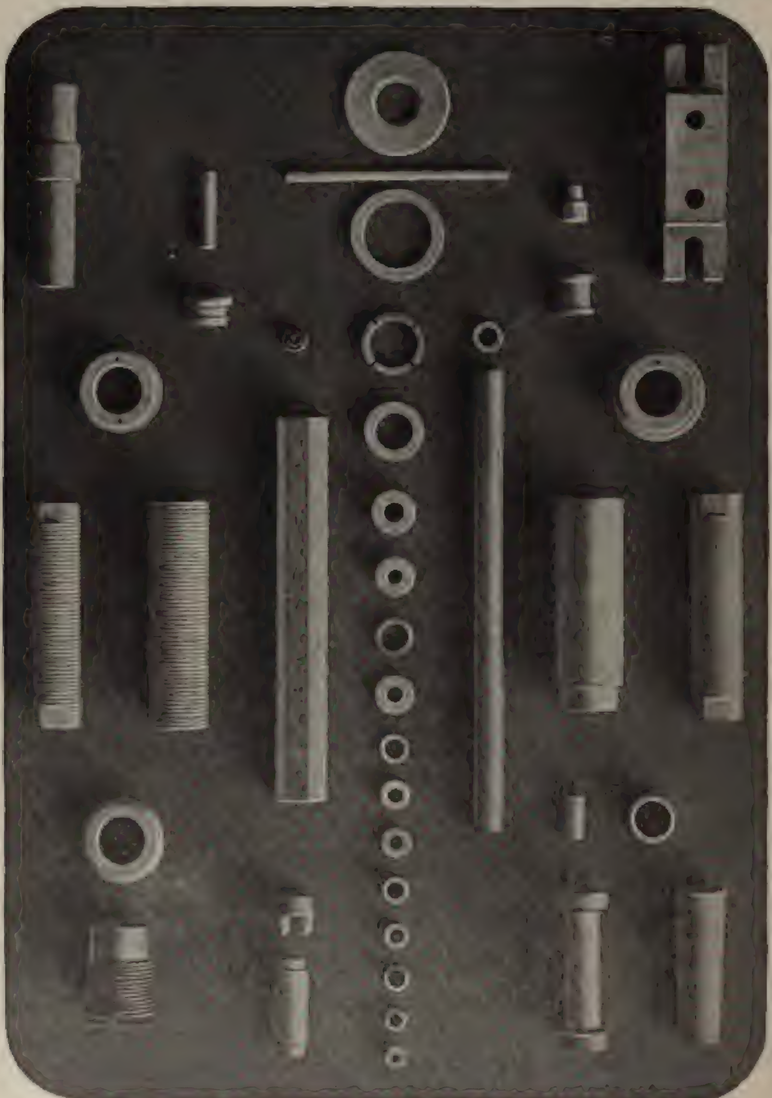
Engineers everywhere know Prof. Unwin, or at least know of him through his writings, and will be interested, therefore, in the announcement made a short time ago that he would retire from active work at the Central Technical College of the City and Guilds of London at the end of the college session. The monthly journal of the college, The Central, has commented on the event as follows:

"It is with the very deepest regret that we have to record the approaching retirement of Prof. Unwin at the end of the present session. The college will thereby lose a professor of whose eminence and ability it would be presumptuous for us to speak, and whose teaching and personal influence will always be gratefully remembered by those who have been privileged to work as his students. Making, as it does, the first break in the original professorate of the college, a professorate which has raised it in a period of a little less than twenty years from small beginnings to its present position, the change is an important event in the history of the Central. * * * Prof. Unwin was appointed to the professorship of civil and mechanical engineering by the institute at the opening of the college early in 1884, and served as Dean from that date until midsummer, 1895, and again during the last two sessions. In 1901, when the reconstituted University of London added a faculty of engineering, Prof. Unwin was made university professor in that subject."

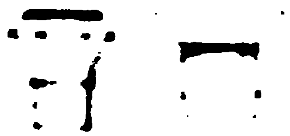
ELECTRICAL.

Uses for Mechanical and Electrical Purposes

method of working highly satisfactory results are clearly obtainable. Arc lamp carbon-guide bushings (as shown above), are made in thousands according to limit gauges allowing from but one and one-half to less than one-half of one per cent. total *variation in* dimensions. For a kilned product, lava offers unusual advantages in respect to uniformity and is much superior to porcelain in this regard.



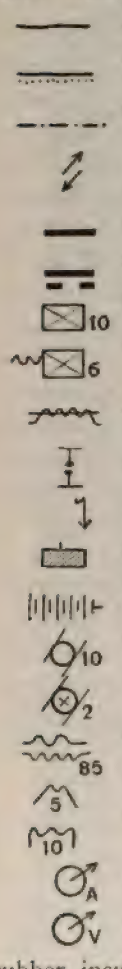
Many tests for dielectric strength made with transformers of large capacity and carefully calibrated electrostatic voltmeters have demonstrat-



Conventional Signs Used by Foreign Electrical Draftsmen

for foreign work, the use of foreign prints with these symbols greatly accelerates the capabilities of the estimate department. The following conventional symbols are used in the three above named countries:

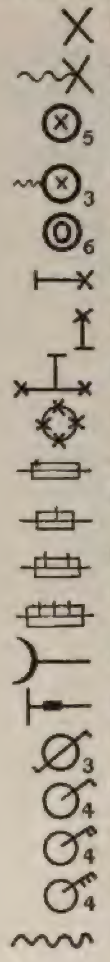
Conductors: B., bare copper; B. E., bare iron galvanized; G., seamless



- Ordinary return circuit.
- Three-wire or alternating-current circuit.
- Flexible conduit, armored (Greenfield type).
- Vertical mains, up and down.
- Switchboard, two-wire system.
- Switchboard, three-wire system, or alternating.
- Rheostat or heating appliance of ten amperes.
- Portable rheostat of six amperes.
- Choking coil.
- Lightning arrester.
- Lightning-rod tip.
- Ground.
- Accumulators or secondary batteries.
- Dynamo or generator, with ten kilowatts capacity.
- Motor with two kilowatts capacity.
- Transformer with capacity of eighty-five kilowatts.
- Two-wire meter, with capacity of five kilowatts.
- Three-wire or alternating-current meter with capacity of ten kilowatts.
- Ammeter.
- Voltmeter.

rubber insulation; L., flexible cords; K. B., bare lead-covered cable; K. A., lead-covered cable with asphaltum-taped cover; K. E., lead-covered cable, armored; g., conductors on insulators; mored; g., conductors on insulators; o., conductors in iron conduit.

Firms making out plans and drawings to be used in the before-mentioned countries will do well to consider these symbols and also carefully to add in figures the proposed amperes to be carried on each wire or cable.—*Popular Mechanics.*



- Fixed incandescent lamp.
- Portable incandescent lamp.
- Stationary group of incandescent lamps; number of lamps, five.
- Portable group of incandescent lamps; number of lamps, three.
- Arc lamps of six amperes.
- Wall bracket (one lamp).
- Standing lamp (one lamp).
- Hanging lamps (two lamps).
- Electrolier (four lamps).
- Wall tube.
- Single-pole cut-out; if a figure is alongside, it denotes amperes.
- Double-pole cut-out; if a figure is alongside, it denotes amperes.
- Three-pole cut-out; if a figure is alongside, it denotes amperes.
- Wall attachment.
- Small branch cut-out.
- Reversing or pole-changing switch for three amperes.
- Single-pole switch for four amperes.
- Double-pole switch for four amperes.
- Three-pole switch for four amperes.
- Single circuit (flexible cord).

The propellers of the fast auto boats revolve 1,250 times a minute, giving a speed of 25 miles an hour.

Two hundred machines which supply newspapers on coins being placed in the slot are now installed in Berlin.

STRUCTURAL.

Wind Bracing in Steel Frame Buildings,

A Theory with Special Reference to Knee Brace Design

BY R. B. WOOWORTH ENGINEERING DEPARTMENT CARNEGIE STEEL CO.

Stability of buildings subject to external forces is a problem to be investigated and solved in accordance with the fundamental laws of mechanics and the strength of materials as determined from the theory of flexure. Any solution of the problem which does not agree with what has been demonstrated as to the behavior of materials under stress must necessarily be imperfect, if not erroneous.

Now, a building may fail in one of three ways, in the direction either of its length or its width. It may collapse vertically by reason of the weakness of the materials of which it is composed and upon which the loads it was designed to bear are superimposed. It may give way in a horizontal direction under the influence of shearing forces, either by lateral displacement from its foundations, or by buckling of its various members on account of their weakness to resist these forces. Or, if the framework is strong enough to carry safely the vertical reactions due to the loads it may have been intended to bear and stiff enough to resist the shearing stresses produced by external horizontal forces, it may yet fail by being overturned bodily through its own weakness to resist the upward reactions produced by these horizontal forces.

The ordinary vertical reactions in a building caused by the loads imposed upon its frame are readily determined and provided for in its design. The external forces which cause horizontal shears that must necessarily be transformed into vertical stresses before they reach the foundations are not so easily taken care of in its design. It is believed, however, that these also can be made amenable to satisfactory treatment and safely provided for. The only external forces acting in a horizontal direction upon a building, with rare exception, are those produced by wind and storms, and these alone produce dangerous effects, tending to overturn the building upon its base.

Now, a masonry pier is a structure subject to horizontal forces similar to those in a building caused by the pressure exerted by the wind, by the action of ice in motion, by collision with boats, or other means. It acts as a homogeneous whole, the blocks of which it is composed resisting all compressive stresses, while the tensile stresses are taken up by the cement, drift bolts, or other means used to bind its parts firmly together into one solid mass. The moment of its resistance to all forces tending to overturn and thus destroy it, is, of course, the

product of its mass into half its width in the line of resultant stress. As on the already mentioned supposition that the pier is a homogeneous whole, its neutral axis passes through its center and is distant from either side of the pier by half its width in either direction, this moment of resistance is equal to the weight of the pier multiplied by the distance from its neutral axis to the outside fiber.

A building differs from a solid masonry pier chiefly in that it is not a homogeneous whole; the vertical loads carried to its base are not uniformly distributed over the entire area of the same, nor are the members of its frame so united as to act vertically, horizontally, or diagonally with the readiness displayed in the several parts of the pier—stones, cement, dowels, clamps, drift bolts, etc. And yet, when we come to consider its moment of resistance to overturning at its base, this moment can only be measured in terms of the several moments of the separate weights resting upon that base by their several and separate distances from the neutral axis. The point of application of these weights can be gotten directly from the footing plan of the building, and the position of the neutral axis, and with it the moment of resistance, determined by the usual formulas.

This neutral axis will not be coincident with the center line of the building, unless the loads are symmetrically applied on the footings. In a steel frame building this is but seldom or never the case; a heavy spandrel wall on one side and a curtain wall on the other, unequal loading due to elevator framing, stairways, vaults, and what not else—these are some of the things which make it necessary to determine the position of the neutral axis by independent calculations at each and every section made by a row of columns normal to the general direction of the axis. But when once this neutral axis is found, and the moments of these separate weights are determined, it will be at once apparent that to insure the stability of the structure it will only be necessary to proportion the several parts of the building in accordance with the laws of flexure. For, of course, the value of the building as a whole, considered as a medium of resistance to the wind, will be the value of its moment of resistance. If, now, the building is strong enough to resist all vertical reactions, and stiff enough to resist buckling under horizontal stresses, and so heavy that its moment of resistance, as thus determined, will exceed the uplift on the windward side due to the overturning moment produced by the wind, there can be no question but that the structure as a whole has been correctly designed to perform all its work.

The horizontal forces by which the pressure of the wind on the sides of a building are represented must be resisted by the internal strains in the various parts of the building, and the work to be done by the wind in overturning or buckling the building must, in view to safety, be equaled by the work done by the parts of the struc- into vertical, diagonal and horizontal reactions, transforming them into vertical, diagonal and hirizontal stresses, and transferring them to the foundations. In this way the sides of the building must act like the

chords of a truss, or the flanges of a beam, and the partitions or end walls like the web members. Now, in a building constructed with solid end walls and partitions represented in sketch No. 1, it is apparent that the end, and what is true of beams in general must be true of these stone or brick beams in particular. They must be figured as cantilever beams fixed at the foundations and loaded uniformly with the wind pressure, and the mate-

building will be safe as against wind pressure only in so far as the transverse walls are strong enough to resist tension and compression caused by the transformation diagonally of horizontal shears into vertical reactions and the side walls are strong enough to resist the crushing or pulling apart, caused by their action as chords. The materials of the interior walls, therefore, would have to be investigated as to their ability to resist shearing intensity, and the outside walls to resist compression, while the cement or other bonding material would have to be designed to resist pulling apart. If, now, the wind forces are considered as concentrated at the outside walls, and at the partitions and sections made at these points it will be readily appar- rials in them must be calculated in accordance with the usual formulas for the flexure of beams in general.

In a steel building of the skeleton type, we have no solid webs, as in the case supposed. The floors are usually open from wall to wall; the partitions are too thin to resist shearing stresses of any great intensity, and their location is never definitely and finally known to the designer, except in special portions of the building, inasmuch as they are liable to removal at the will of the tenants. The end walls, likewise, are cut up by openings for doors and windows, and there could, in no case, exist any true bond between the materials of the wall and the steel spandrel beams or girders. Consequently, the designer cannot rely, in

ent what is the true character of the building as subject to mathematical investigation.

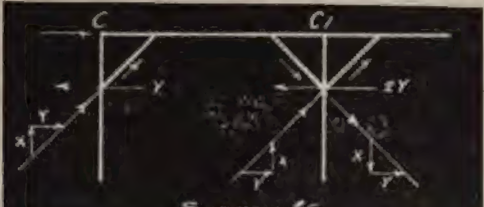
As shown by sketch No. 2, we have a series of beams and channels on any measure, upon them for aid in resisting the wind forces. The stiffness of the floors, the resistance of the partitions, and the general rigidity of the building, due to careful attention

connections, may avail much or little. It is the duty of the designer intrusted with the responsibility for the interests of the owners, and the security and perhaps the lives of the tenants, not to rely upon elements of strength, uncertain in value and irreducible to calculation. What shall he do? The answer is easy. He must make provision in his design of the steel frame to resist these horizontal forces. If he can put in diagonal systems of wind bracing at any point, let him do so, and let him design them for the full force of the wind contributory to the area covered by their influence. If he cannot make them sufficient for the total wind force, let him make force, let him make them as strong as the dead load in his columns will allow; but let him beware lest he pull up his columns bodily by the roots. If he cannot get material enough in this way to resist the figured wind pressure by such tower bracing, considering the building as a cantilever truss, with center to center of chords equal to center to center of the columns thus braced, he must do what he can further in the line of knee braces, lattice girders or portals. The calculation of a diagonal system is simple; it is believed that the method now to be outlined for bracing with plate or lattice girders and knee braces is in exact accord with the fundamental laws which must govern all calculations involved in the investigation of stability in structures.

Let a transverse section of our steel frame building be represented in sketch No. 3. It is proposed to use girders and knee braces to resist the wind forces and to transfer them into the foundation. If now the building be the same as that already discussed, with the exception that the place of the partition walls is taken by the columns, it is certain that the moment of resistance at the footings must be the same as before, lessened by the difference between the weights of the walls, etc., and the weights carried by the steel frame. The area of the base is the same, the lever arms are the same, and

the only difference consists in the weights themselves and their modes of application at the footing line. The moment of resistance of the building, considered as a whole, must be computed in the same way, viz., by reference to the neutral axis. On this principle, the stresses in the outside columns must be computed as for a cantilever beam. The moments of the several wind forces about "R" or "L" will be equal to their several intensities by their distance above these points, and the stress in the outside columns (fibers of our cantilever beam) will be the quotient of their sums (total bending moment about "R" or "L") divided by "b," the depth of the beam. This stress will, of course, be tensile in the windward column, and compressive in the leeward, and equal each to the other, and will have to beadded to theother stresses in the latter column caused by the vertical loads. The tensile stress in the windward column must not exceed the steady load (dead and a small live load) on the column, otherwise anchorage must be provided to resist the upward reaction.

Let us lay our building on its side, as shown in sketch No. 4, omitting the interior columns and braces, and consider it as a cantilever beam as before. Now the forces P1, P2 and P3 produce longitudinal compressive and tensile strength, and vertical shearing stress in our beam. Take the longitudinal stresses a moment. At the top of the beam these are tensile, at the bottom they are compressive, at the neutral axis they do not exist, but at any area between the neutral axis, as at "A" and "B" and the top of the beam, or similarly between the bottom and the neutral axis, they do exist, and their intensity is directly proportional to their distance from the neutral axis. If now these areas "A" and "B" extend from end to end of the beam, the strip of beam represented by them must be subject to longitudinal stress at all points. This stress will vary in intensity parallel to the intensity of the stress in the top flange, and will always be in direct proportion thereto. By reference to sketch No. 3 it will be seen that these areas "A," "B," "C" and "D" lie in the plane of column C1, C2, C3 and C4 It would appear reasonable, therefore, that if we leave out the strip of web plate between the top of the beam and "A," or between "A" and "B," as we propose to do in the use of knee braces, any columns at these planes would be stressed in proportion to their distance from this neutral axis, just exactly as they would be were the web plate entire. That is, if we leave out the solid partition walls depended upon in our primary consideration to transform horizontal shear



SKETCH #5.

into vertical stresses and replace them by columns and brackets, these columns and brackets must do the work supposed to be done by the walls. Moreover, were the structure to fail by deflection from the straight line, it must do so as the result of forces causing the tension flange to elongate and the compression flange to shorten as the result of the work done by them in straining the structure. It need not be said that the interior columns must follow suit, and lengthen or shorten accordingly. Any work done, therefore, by the wind to induce such deflection and failure must be resisted by internal strain in these interior columns.

As to shearing effects, in a rolled beam or in a plate girder without stiffeners, the shear is constant from the top of the beam to the bottom, and its intensity per square inch is equal to the shear at any point, divided by the area of the web plate for a strip an inch wide. The portion of the total shear taken by any section of the plate would then be equal to its depth, divided by the depth of the girder. By reference to sketch No. 4 it will be seen that if the portion of the web represented by area "A" be taken to include one-half of the whole strip from the line at "B" to the top of the beam, we can consider the whole shear in that section to be concentrated at "A" and acting as a unit at that point; on which consideration we have to assume that if the web is cut away, as a force at "A" to balance this shear, otherwise our structure will fail. Now, the only stresses in our structure under present consideration are those caused by these shears in their transference from horizontal to vertical reactions. The work of this transfer is done by the brackets. The columns cannot take horizontal stresses for transmission to the foundations until the same have been transferred into vertical reactions. This transformation must be done by the brackets, and the proportion of horizontal shear taken by each bracket from the line of girders will, if our analysis be correct, be determined by the contributory area of our web plate. If our columns were spaced equally, then the outside columns would each receive one-tenth of the total shear, while the interior column would receive twice as much, or one-fifth each, strictly in proportion to the amount of web plate represented by its contributory area at any section. This also seems to result from an analysis of these brackets.

Suppose the brackets to be equally strong, then each bracket will take the same amount of shear from the girder, which now represents the thin strip of web plate and which is supposed to be equally stressed from end to end. Suppose the brackets to be cut at 45 degrees. Suppose the amount of shear taken by the bracket at column "C" to be "y" (horizontal component). The bracket takes this shear by bending the girder vertically, equal to component "x," and the column horizontally equal to component "y." At column C1, as shown by the sketch, the bending in the column amounts to two "y," which is as it should be on the supposition made. The interior columns then on equal spans center to center of columns should be calculated to resist twice the bending taken by the outside columns. The vertical stresses in the columns caused by the knee braces cannot be determined by an analysis

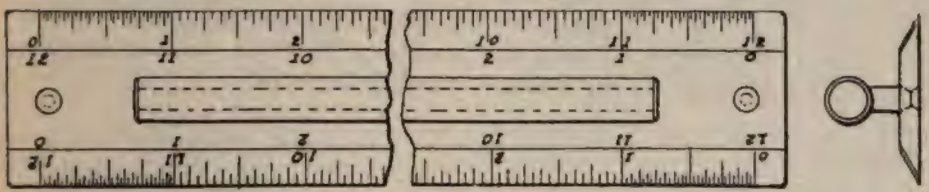
of their reactions. For at column C1, by the analysis on sketch there would be no vertical component to go into this column, and of the total shear at this level all that would produce vertical reaction in the columns would be one-fifth of the total, which is supposed to pass into the exterior columns. If the accumulated shear at this level were 1,000 pounds, then, by analysis of the bracket, the outside columns would take 100 pounds each as increment of chord stress, whereas, for ten-foot story and a ten-foot span they should take $\frac{1{,}000 \times 10}{50} = 200$ pounds. The stresses in these brackets and bending moments in girder and columns must therefore be computed in accordance with the methods given in the standard works on portal and knee bracing in bridge construction. The vertical reactions are obtained in line with the analysis of cantilever beam work, to which allusion has already been made.

"Fireproof Magazine."

Editor *The Draftsman*:

Having noticed articles in *The Draftsman* of late in regard to simplifying a draftman's work, and thinking the readers might still be interested in another, I enclose a sketch of a special scale I had made to order.

The scale is graduated full size on both edges, with the end inches 32ds and the intermediate inches in 16ths, numbered from both ways.



With this scale any line can be scaled at once without turning the scale end for end or over, as some of the four graduations will come right.

The handle makes it as easy to pick up as a triangular scale and is always right when laid down.

The small circles at the ends are of soft rubber, which prevents it from sliding off the drawing board, even at a 45° slant.

I also find these little rubbers work equally well in triangles.

I believe every draftsman would find it a great convenience to have as many different scales as their work required, as the first cost is small, when considering time saved using the scale instead of the old-fashioned triangular scale.

E. A. Chamberlin,

In China a mile is anything from a quarter of a mile to a mile and three-quarters, according to the province in which it may happen to be.

Captain Fritz-Egger, a Swiss cavalry officer, has invented a method of horseshoeing by fastening the shoe to the hoof with metallic bands.

HOME STUDY.

COURSE II. Machine Design

Chapter III.

Pipes and pipe fittings enter so often into the work of the machine designer that a chapter has been put in here to show the form of some of the most common connections and the method of calculating pipes for strength.

Pipes used in engine and boiler room equipment are of wrought or cast iron, made in standard sizes from $\frac{1}{8}''$ internal diameter up and from 16′ to 20′ long. For sizes above 16″ diameter, pipes are of cast iron. Connections for all sizes are of cast iron. For the small sizes, pipes are usually threaded and screwed into the fittings. For large sizes, they are made either with flanges cast on, or they are threaded and a flange is screwed on which bolts to a flange on the fitting.

The headings to the other columns will explain themselves.

The designer often has occasion to use the columns giving weight and capacity in laying out systems for steam or water. The external area is used in calculating the radiating surface, as for example, in steam heating plants, where pipe coils are used as in Fig. 1.

Standard piping is tested to pressures higher than are ordinarily used in practice so that the draftsman has only to select from the table the size of pipe he wants, but he may have occasion sometimes to figure the thickness of a pipe for himself.

A method for doing this is given and it will be seen that it is similar to that used in Chapter II for calculating a steam cylinder.

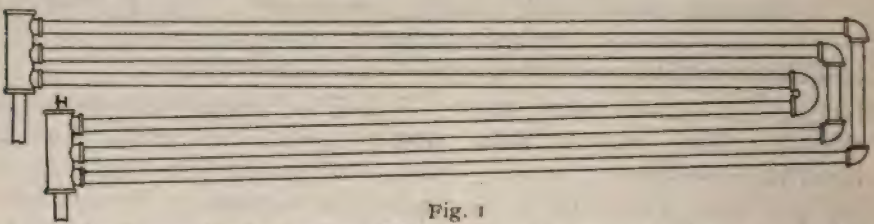


Fig. 1

A standard wrought iron pipe table is shown on page 194, Kent's Mechanical Engineers' Pocketbook. (See supplement to *The Draftsman* for July.) In the first column of the table, is given the nominal inside diameter, which is a little less than the actual inside diameter. This is the size that is always used in specifications. The headings to the other columns will ex-

Let d=internal diameter of pipe in inches.

Let l=length of pipe in inches.

Let t=thickness of pipe in inches.

Let s=tensile strength of material per square inch.

If a section of pipe of any length be taken, it will be seen by referring to Chapter II that the resistance to bursting=2tls and also that the bursting

pressure=pld.

Equating these, we have: 2tls=pld.

$$\text{or } t = \frac{pd}{2s}$$

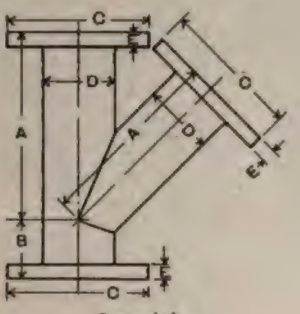
The thicknesses given in the table referred to above correspond to a tensile strength of 4,000 for wrought iron and a factor of safety of about 10. The pipes being tested to 500 lbs. per sq. in.

Elbows

Tee.

For cast iron pipes, s should be taken at about 18,000 with a factor of safety of 5 to 6.

The fittings used in steam and water piping are of malleable or cast iron They are named according to their shape, tees, elbows, crosses, etc.

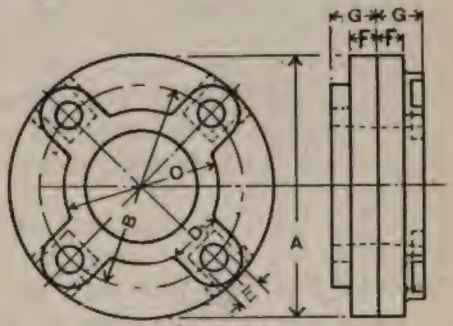


Laterial.

Manufacturers' catalogues, giving standard sizes and shapes, can usually be had for the asking. Crane, Lunkenheimer, Crosby and Walworth are standard and well known, or the book published by *The Draftsman*, giving dimensions of Pipe, Fittings and Valves.

To make this plate, get one of the catalogs above or some other and lay out the several pieces indicated from the dimensions given in the tables of the catalog.

1. A 2" x 2" x 1½" T (screwed fitting.)



Flange Unions.

2. A 2½" elbow (flanged fitting.)
3. A 45° 6" lateral (flanged fitting.)
4. A 2" flange for low pressure (screwed fitting.)
5. A 1½" union.
6. A 3" x 2" straight reducer (flanged.)

The student will have to pick out a suitable scale for these pieces so as to get them all on the drawing.

Practice in such work is necessary. Get approximately the size of the pieces, then determine the best scale to use, and divide the plate off roughly into spaces for their accommodation. The dimensions of this plate will be the same as in the previous chapters. (14 x 19 with 13 x 17 border lines with ½" margins at right, top and bottom and 1½" at the left.)

Malleable Unions.

CURRENT TOPICS.

The Evolution of a Note Book.

By E. J. Lees.

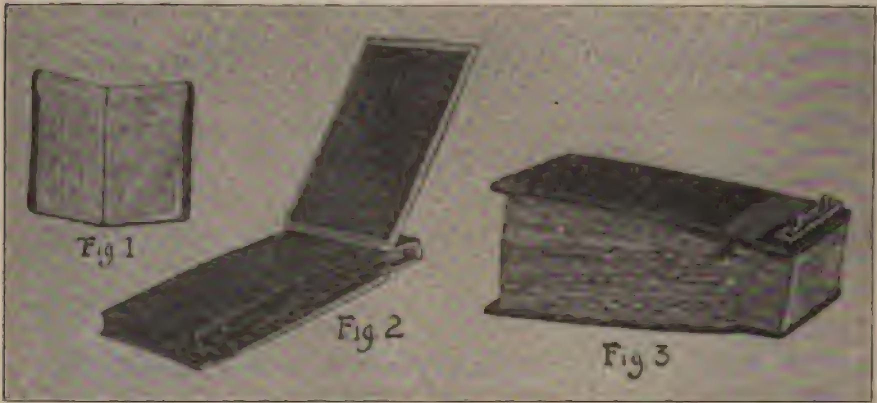
A number of years ago the writer decided to start a note book along mechanical lines, and the small alphabetical indexed one shown in Fig. 1 was purchased.

At first, all items of interest and of use in the drafting room were copied in this book with India ink, the work and time, of course, being considerable, and as each letter was limited to a few pages the natural result was that the space for the most used letters was soon filled.

Then it was a question of another book, or paste in between the filled pages, which soon made the book clumsy and broke its back.

Soon after the book reached this stage the standardization of catalogs, etc., was recommended and the mechanical periodicals took up the idea. One of them especially began publishing data sheets 6 by 9 inches as a supplement. (The Draftsman is using the same size.) As this idea became more generally adopted, catalogs and other printed matter began to appear in this size, and since they often contained much useful information which either required copying or a larger book, arranged to hold these pages.

In looking for something to hold these loose pages, data sheets and blue prints, the spring back binder was adopted and matter that was collected was placed therein, as shown in Fig. 2.



This went fairly well, but as the collection grew an index was necessary, so the adjustable index tags were adopted and placed along the edges.

This made a very good arrange-

ment, but has its drawbacks, as follows:

First.—The springback is limited as to its capacity.

Second.—The index tags are rather thick and give the pages a wedge section, which has a tendency to assume a fan shape, and to offset this brass fasteners were inserted. This held all right, but when a new sheet was to be inserted all sheets had to be removed and replaced in order again.

Fig 4 Fig 3

Third.—Unless one has a good memory it is rather tedious to look over the tags to find the article wanted.

A next move was to secure a sectional post binder (See Fig. 3), and a quantity of plain paper cut to suit this binder (See Fig. 4).

It will be noticed that these pages are notched through the back, thus allowing them to be placed in position without removing the other sheets already in place.

The use of this book is as follows, and, as far as the writer knows, is original.

Data sheets, blue prints, photographs, etc., that are 6x9", or nearly so, are all glued on to the plan 6x9" sheets at the inside edge only, this point is very particular, as when the book becomes large, the curvature when open will break off the glued part or tear it, if glued on either top or bottom edge.

Articles published in magazines or any small reading matter scattered around a cut, for instance, are clipped out and arranged on the plain sheets to be inserted, always bearing in mind that the gluing must be done on the edge toward the binders.

Tables from catalogues, etc., that are printed on both sides and sometimes take two pages to a table of

dimensions, may be pasted in as follows: Glue on to the plain sheets, taking care to keep the reading in line, as it was in the catalog, and then cut away the blank page in between, leaving only the perforated portion at the post to bind with.

The indexing is alphabetical in connection with numbered subjects. (Fig. 5.)

The plain sheets are used for the alphabetical index and may be typewritten, a large heading for each letter and the subject and subject number in line underneath. The numbers for the subjects may be as many as desired, the number being fastened to the first sheet only in each division, thus allowing expansion or contraction and rearrangement, a sheet being easily pulled out when those above are lifted slightly.

These numbers are printed on tracing cloth about ½" wide, and are doubled and glued on each side of the sheet, making a very substantial tag which projects out far enough to be easily located, and are also staggered, or put on one below the other, in numerical order, the note book shown up to date having 44 numbers.

The method of determining where to place any new sheet is very simple, from the fact that one does not depend entirely on all matter being exactly the same nature under each number.

For example, look up *Bolts*, in the alphabetical index. We find it under No. 19. Suppose we have some data on nuts to file, instead of starting a new number for this, we file it under 19 also, taking care that under the letter *N* we enter *Nuts* No. 19.

In a few days some data on taps is received. Now we can either start a new number under T, or if No. 19 is not too full for easy handling, we can also file this under No. 19.

Should No. 19 eventually become too bulky, start a number, or remove the subject most used, and change the index to suit.

Up to date, however, the writer has not found it necessary to rearrange the matter this way, as a little care in noticing the quantity of material in a section will govern the location before being filed.

The good feature of this system being that only the first page of each section being numbered, it makes it possible to change without erasures, etc., and the alphabetical index, as fast as filled up, can be retypewritten and allowance made each time for additional items, thus making the whole scheme flexible in every direction.

The number tags are started from the binder end at the top, No. 1, down to the bottom edge, then to the top again, the thickness of sheets and insertions making it easy to see the second and third row of numbers.

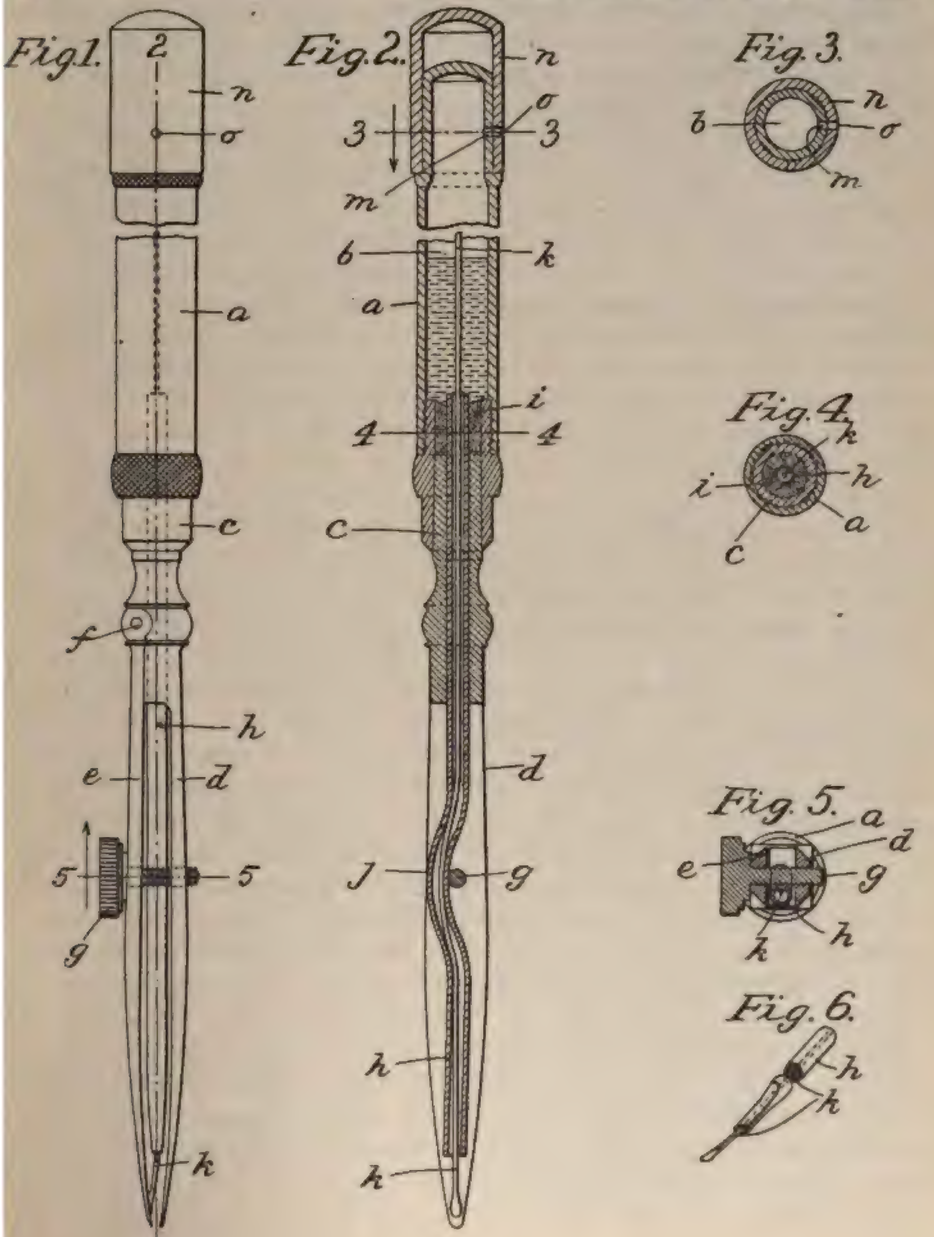
Some data sheets are published with two or more different topics. These can be cut up to locate under different heads or can be filed as they are and index numbered to suit.

The new Springfield rifle is probably the most effective military arm in the world. At a distance of 50 feet it penetrates 55 one-inch pine boards placed one inch part. It has a muzzle velocity of 2,300 feet per second and carries a ball five miles, although one mile is the greatest distance that any rifle can be effective, even with telescopic sights.

Drawing Pen.

The invention relates to the construction of drawing-pens and it has for its object the production of a pen of this type which shall be self-feeding.

The reader is aware that it is not broadly new to provide an ink-reservoir for ruling-pens, but such pens are in almost constant use, and it is not as difficult, therefore, to adapt a feeding



device thereto. With drafting-pens the case is otherwise, for their use is not constant and the inks usually employed therewith are quick-drying, relatively non-limpid, and these facts greatly affect the question of feed and affect it adversely.

This invention consists in constructing an ink-reservoir in the handle of an ordinary drafting-pen and in providing a feed-tube whose eduction end is located near the nibs of the pen, the reservoir being provided with a vent in the upper end thereof, which may be opened to allow ink to fill the space between the end of the feed-tube and the nibs, the vent being then closed to prevent further excessive feed. If, therefore, a pen be laid aside, the ink between the nibs may dry up; but the pen may be opened and cleaned, as with ordinary pens of this type, and another supply of ink permitted to flow to the point thereof. When the pen is in use, the vent may be opened more or less to permit the supply to the point of the pen to be renewed as needed.

In the drawings forming part of this application, Figure 1 is a side elevation of a pen embodying this invention, considerably enlarged. Fig. 2 is a similar view in section. Fig. 3 is a cross-section on line 3 3, Fig. 2. Fig. 4 is a similar section on line 4 4, Fig. 2. Fig. 5 is a cross-section on line 5, Fig. 1; and Fig. 6 is a perspective view of the delivery end of the feed-tube and feed-wire therein.

Referring to the drawings, *a* is the handle of the pen, which is hollowed out to constitute a reservoir *b* for the ink. This handle has one closed end, and its opposite end is threaded and screwed onto the metal shank *c* of the pen, as shown in Fig. 2. To this shank one of the legs, *d*, of the pen is rigidly secured, the other leg, *e*, being hinged to the shank at *f*. An adjusting-screw *g* for these legs is applied thereto in the usual manner, whereby the points of the pen may be adjusted, these points being adapted to be brought together under the spring resistance of one or both of said legs, as usual.

The shank *c* has a hole drilled through it axially to receive the feed-tube *h*, the inner end of which is substantially flush with the threaded end of the shank, onto which the handle of the pen is screwed, and the end of the tube is sealed therein in any desirable way, as by the packing *i*. This tube *h*, emerging from the shank, passes down between the two legs of the pen and has a curve *j* formed in it to allow it to pass around the adjusting-screw without interfering with the functions of the latter, and the end of the tube is flattened, as shown in Figs. 1 and 6, to permit the two points of the legs to be adjusted toward one another without contacting with the tube. The end of the feed-tube *h* is located at some distance above the points of the pen, and the space between these points and the end of the tube constitutes the ink-space. The feed-wire *k* is located in the tube *h* and extends from the point of the pen somewhat beyond the inner end of the feed-tube and into the ink-reservoir *b*, and that end of the wire lying between the pen-points is flattened, as shown in Figs. 2 and 6, and is bent slightly to one side to bring its flattened point against the point of the movable or pivotal leg. As the wire fits loosely in the feed-

tube, the adjustment of the pivotal leg will move the wire more or less within the delivery end of the tube, thus keeping clear this end, which is somewhat restricted in area by being flattened, and thus insures a freer delivery of ink. The wire *k*, being forced into the feed-tube after the latter is bent around the screw *g*, is held in any position relative to the pen-points by reason of the bend formed therein, as it is passed through the bend in the tube, wherefore this frictional engagement is sufficient to hold the feed-wire against endwise displacement without the aid of additional fastening means, thereby simplifying the device.

To permit the free flow of ink to the pen-points through the feed-tube *h* when it is desired to fill the pen for use, means are provided for admitting air into the upper closed end of the reservoir *b* above the level of the ink, which consists in boring a small hole *m* through the wall of the reservoir and fitting thereover a cap *n*, the upper end of the reservoir being turned down to receive this cap without enlarging the diameter of the reservoir. Through the wall of the cap *n* another small hole *o* is drilled adapted to be brought into registration with the hole *m* to vent the upper end of the ink-reservoir.

Geo. R. Pyne, Springfield, Mass., is the inventor.

Drawing Board.

This invention relates to drafting, and more particularly to that class of devices thereunder known as "drawing-boards;" and its object is to provide a device of this character which shall be simple in construction and of great utility to the draftsman.

Figure 1 is a perspective view of a table embodying the invention. Fig. 2 is a plan view of a portable board, showing the slot-cover in place. Fig 3 is a plan view of the slot-cover. Fig. 4 is a section on line 4 4, Fig. 1. Fig. 5 is a cross-section of the slot-cover. Fig. 6 is a section on line 6 6, Fig. 2. Fig. 7 is a similar view with the parts separated.

The letter B designates the board or tabletop proper. It is essential to this invention that the space below the board shall be open. Hence in Fig. 1 the board is illustrated as being supported on a spider *s*; but it will be understood that the board may be made in the portable form shown in Fig. 2 and supported in any desired manner. The upper surface of the board is shown as being covered by some suitable sheet material *c*; but this covering may be omitted without departing from the spirit of the invention. The board is provided with a slot S, which may be located, as preferred, within the periphery of the board. As clearly shown in Fig. 4 the opposite side walls W are beveled at *w* and *w'* on their upper and lower edges, respectively, forming sharp ruling edges *e*. We prefer to cover these ruling edges with brass *m*, secured along one edge beneath the covering and at the other edge to the lower bevel. Each upper bevel is in a plane substantially parallel to, but spaced from

the plane of the opposite lower bevel in order to enable a tablet or slate to be firmly held between them while lines are being drawn on its surface.

The operation will be readily understood by referring to Fig. 1, in which a tablet is indicated in dotted lines as resting against one of the end walls E of the slot and braced by the bevels on the side walls. These end walls are accurately squared and preferably brassed, so that a series of parallel transverse lines may be quickly drawn on a suitable surface by slipping it up or down in the slot and using the exposed ruling edge at the desired points.

In Figs. 3 and 5 is illustrated a slotted cover C, which is used in connection with the board. This cover is suitably beveled, as at *b*, upon its lower side edges, so as to fit accurately within the slot with its upper surface exactly flush with the face of the draw-

Fig. 1.

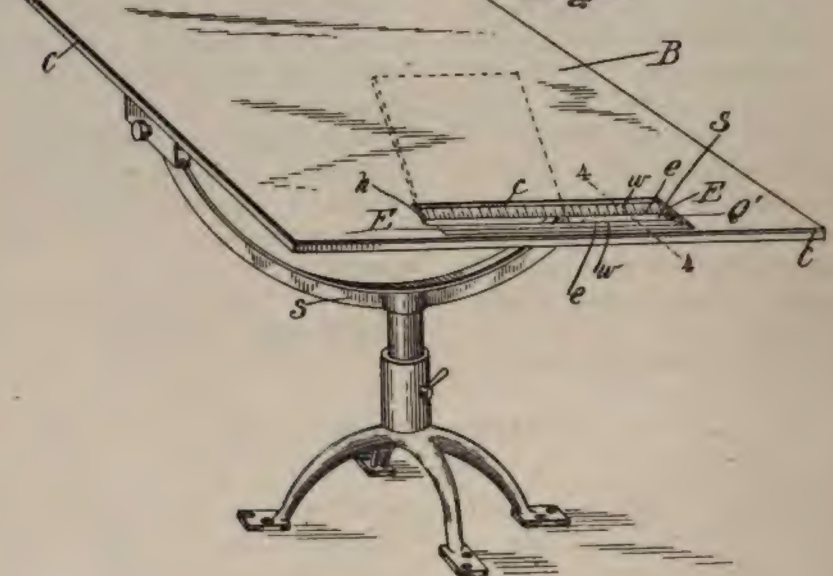


Fig. 2.

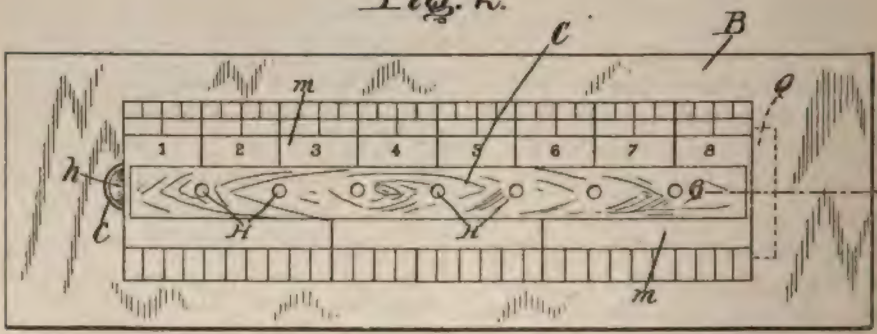


Fig. 3.

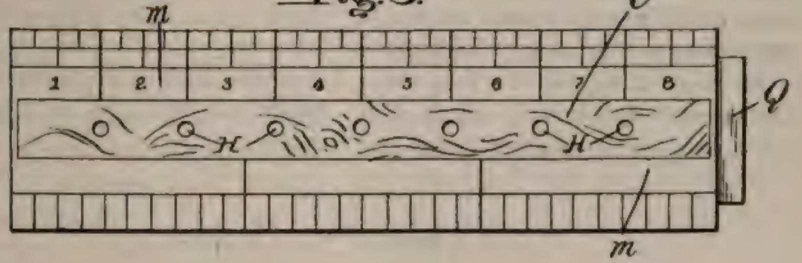


Fig. 4.

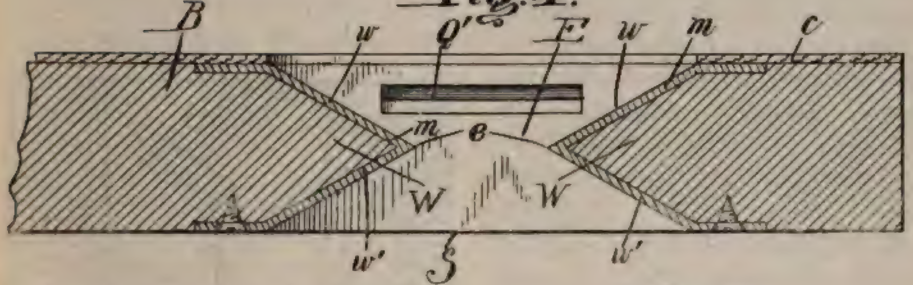


Fig. 5.

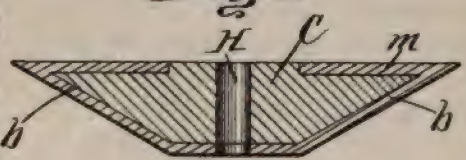
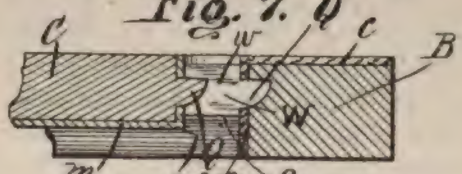


Fig. 6.

Fig. 7.



ing-board. One end of the cover is provided with a projecting tongue Q, which has in cross section the form of a lower quadrant of a circle—that is, it has a flat upper face and a curved lower face. The adjacent end wall of the slot has formed therein a socket Q′, also quadrant-like in cross-section, which is adapted to receive the tongue Q. The opposite end wall has a thumb-hole *h* for convenience in lifting the cover. This form of tongue and socket is considered of great value because the flat upper faces of the quadrants form a secure bearing-surface preventing tilting of the cover, while the curved lower face permits its removal without danger of breaking the tongue or enlarging the socket.

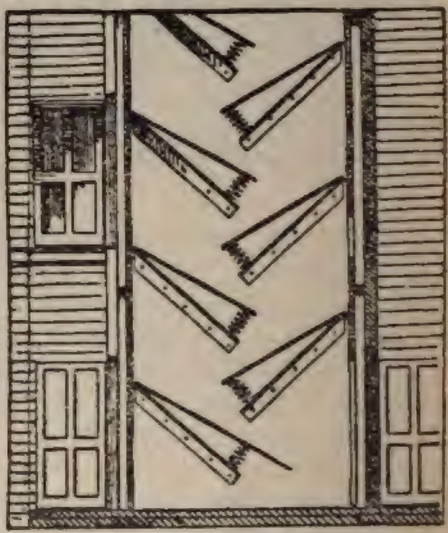
It is obvious that the slot-cover may be employed as a separate ruler, and it may have scales of different standards engraved upon its faces. In like manner the side walls of the slot are furnished with suitable measuring-marks. The cover may also be pro-

vided with a series of holes H, which adapt it for use as a sort of beam-compass, as will be readily understood, by inserting chalk crayon, or pencil-lead through one hole to mark with and by inserting the rubber-tipped end of the pencil through another hole to be used as a center, yet without making a mark.

Jacob Shellhammer, Isaac P. Henthorn and Wm. A. Hill are the inventors.

A Unique Fire Escape.

Here we have a fire escape, invented by Philip H. Dedrick, of Grandview-on-Hudson, N. Y., which stands in a class alone as far as novelty is concerned, having a unique feature which has probably never before been applied to the work of saving people from burning buildings. As will be seen, the idea is to erect a series of rigid platforms alternately on opposite sides of a well inside a building or between two buildings, setting each platform at such an angle that anything sliding from it will strike on the next platform, at right angles to the first. This of itself would break the force of a fall, and a person would drop from the roof to the ground with no more serious injury than a severe shaking up; but the inventor has placed a spring cushion on each of these platforms, which would reduce to a minimum the jar occasioned by a fall from one platform to the next. As a person drops on one of the cushions it yields beneath his weight, and then discharges its burden to the next cushion, and so on, until the bottom



FIRE ESCAPE.

of the well is reached, when the person picks himself up and makes his escape through one of the exit doors provided, none the worse for his fall.

Book Notices.

The writer of "Stair Building Made Easy" has a good remark in his introduction, that so many books on the subject are written by men who do not seem to think it necessary to begin at the beginning and teach the young workman how to build a stair of the simplest kind and then lead him up step by step until he is able to erect and complete stairs of better description.

This cannot be said of this book, and that it has other attractive features is found in the fact that this is

the third edition, enlarged and revised greatly and still at the same price, $1.00.

While it is intended as a book for the workman yet it is quite valuable to the architectural draftsman, since everything is discussed in a very practical manner.

The book is published by The Industrial Publication Co., 16 Thomas street, New York, N. Y.

The student in Physics, or any of our readers who are interested in experimental work, will appreciate a copy of "Practical Measurements in Magnetism and Electricity," written by Mr. Geo. A. Hoadley.

The purpose of the book is to meet the requirements of students in scientific courses, as well as those of the practical man who wishes to become familiar with the foundation principles of the subject.

The student will need some apparatus and he may be able to add to it by building some of his own design, but in the end, if careful in keeping notes, etc., he will be much advanced in the subject.

The book is 5x7½, with 110 pages, cloth covered board backs, and well illustrated and printed. Price ——. Published by American Book Company, Cincinnati, O.

Self-Propelled Vehicles: A Practical treatise with illustrations, by J. E. Homans, A. M., 8vo, pp. 672, bound in black vellum, gilt top, gold titles. Theo. Audel & Co., Educational Booksellers, New York. Price, $2.00.

In presenting the new edition of this work, the publishers announce that the book has been thoroughly revised, and in large part rewritten.

There is a vast amount of useful information packed into its 644 pages and it is so well arranged and so clearly stated that the reader cannot fail to find and comprehend the information given.

The general principles of automobile construction and operation, including steering devices, underframes, wheels, tires, bearings, and lubricators are included in the opening chapters. Then follows an exhaustive account of the theory, construction and operation of gas engines, occupying over 100 pages. Several typical engines are taken up and discussed separately, and their properties, as regards balance, speed and power, are discussed in the light of fundamental principles. The explanations of the governing devices are clear and valuable, while the discussion of ignition, including the hot-tube, and the primary and secondary sparks, cannot fail to prove of the utmost value.

Probably the most interesting feature of the entire work is the extensive chapter devoted to the description of leading types of gasoline vehicles, including the most important of American build. In this chapter the reader is informed as to the details of the transmission and control apparatus in each case. The chapters on electric vehicles are also full and certain to prove of practical use to the owner and chauffeur. Taking the subject of electrical apparatus from the fundamental principles of circuits and batteries, the discussion passes to the theory and operation of generators and motors; the laws of motor

operation; the laws involved in computations of speed and power, and the varieties of motor suited to road carriages. Electricity meters are described and illustrated in a brief chapter, and the principles underlying storage batteries, their construction and care, are outlined.

All necessary information is given, and the merits of several types of steam carriage are fully set forth.

"Modern Estimator and Contractors' Guide for Pricing All Builders' Work," by Fred T. Hodgson. Bound in cloth, 250 pages. Price, ... Frederick J. Drake & Co., Publishers, Chicago.

The book that attempts to give exact figures as to the estimates of building will be often in error, because of the ever changing prices of material and labor.

There are, however, certain rules and constants of measurements the estimator may use which may be re- ed upon as being correct, and it is the aim of the writer of this column to show these facts in an understandable manner.

The main factor to be employed in estimating is experienced judgment and without it no estimator can expect any great degree of success.

Great pains have been taken to collect such exact information as may be useful in estimating, either in the office or on the building, with the object of forming what is believed will prove a valuable addition to building literature aside from simply a price book.

A man with an aim will sooner or later be a man with a name.

FACTS ABOUT GLASS.

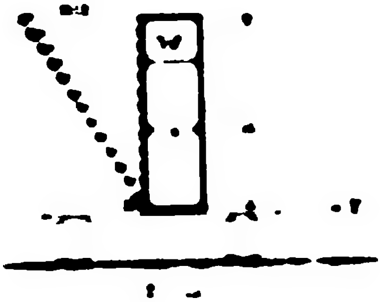
The oldest specimens of glass, says an authority on curious information, are traced back from 1,500 to 2,500 years before Christ. These are of Egyptian origin. Transparent glass is believed to have been first used about 750 years before the Christian era. The Phoenicians were supposed by the ancients to have been responsible for the invention, and the story will be recalled of the Phoenician merchants who, resting their cooking pots on blocks of natron, or subcarbonate of soda, found that the union, under heat, of the alkali and the sand on the shore produced glass. There is little doubt, however, that the art of glassmaking originated with the Egyptians. It was introduced into Rome in the time of Cicero, and reached a remarkable degree of perfection among the Romans, who produced some of the most admirable specimens of glass ever manufactured; an instance is the famous Portland vase in the British Museum. Glass was not used for windows until about A. D. 300.

HUNDRED MILES AN HOUR.

The first of thirty electric locomotives being built by the General Electric Company for the New York Central Railroad has been completed, and will be tested before the remaining twenty-nine are built. The New York Central has given the use of one of its freight tracks near Schenectady for the test. A third rail is being laid to carry the electric current, which will come from a specially constructed transformer station. Six hundred volts will be used.

THE DRAFTSMAN

Moment of Inertia and Flexure



thus $E = fd$ and $f = E$, where $E =$ Energy, $f =$ the acting force and $d =$ the distance through which it acted. The force of M acted through the distance d, and the force of Mn through the distance dn. Hence, $f = E$ and fn

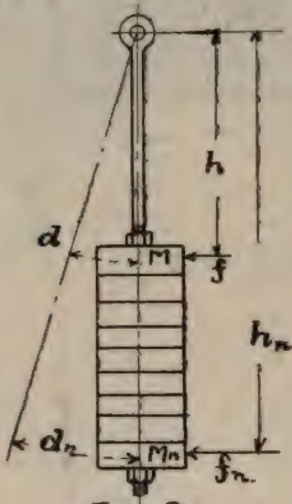


FIG. 2.

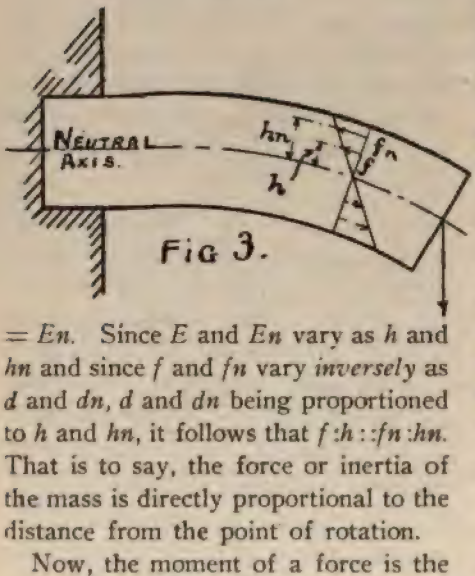


FIG 3.

$= En$. Since E and En vary as h and hn and since f and fn vary *inversely* as d and dn, d and dn being proportioned to h and hn, it follows that $f{:}h :: fn{:}hn$. That is to say, the force or inertia of the mass is directly proportional to the distance from the point of rotation.

Now, the moment of a force is the product of that force and the length of its lever arm, thus the distance from the point of rotation enters as a factor twice when calculating the moment of inertia, and this moment is then proportional to h^2, h^2n, etc.

In flexure one is treating quiescent loads; mass and velocity do not enter as factors; hence, inertia is not a factor in the strict sense of the term.

The first principle in flexure is, that stress and strain are proportional, i. e., if a load of one ton elongates a rod 1-100 of an inch, a load of two tons would elongate the same rod 2-100 of an inch, providing the elastic limit were not exceeded.

When a beam is loaded it deflects or bends, the fibers are elongated or compressed in proportion to their distance from the center, and it is for this reason that the forces vary as the distance h, hn, etc. At the center they are neither elongated nor compressed, this line has been termed the neutral axes.

Now, the magnitude of the force being proportional to its distance from the axes and its moment being equal to the magnitude times the distance; distance (h, hn, etc.) enter twice as a factor, making the moment of forces induced by flexure vary as the square of the distance. While the principles involved are entirely different from those of inertia, the values of the moments in both cases vary as the square of the distance from the point of rotation and we have thus come to use the term *moment of inertia* when we really mean *moment of flexure*, for no other reason than that they are equal in value.

If text-books used the more logical term, considering inertia and moment due to it along with mass, velocity, energy and work, the subject would be much easier to grasp. In other words, call a thing by its right name.

Editor *The Draftsman*:—

The writer is of the opinion that an erroneous idea is conveyed in the article on "Beams and Planes Severally Supported and Loaded," appearing in the August issue of *The Draftsman*.

For formulaes 6, 7 and 8, in reference to Fig. 2 of the article, to be applicable one must assume the beam to be *inflexible* and the reactions *uniformly elastic*. Elasticity is one of the general properties of matter, therefore, all beams, when loaded, will deflect. The foregoing then becomes an impossible condition. Fig. 1 illustrates the nearest approach to these conditions in a practical sense.

Taking the beam *xx* as being loaded to but a small percentage of its ultimate safe load, thus reducing flexure to an inconsiderable factor, and the reactions *A*, *B* and *C*, as being produced by springs of equal strength and elasticity.

It is evident that the distortion (compression) of the springs *A*, *B* and *C*, is proportional to their distance from the point of rotation *y*, and since stress is proportional to strain within the elastic limits, the forces at *A*, *B* and *C*, are also proportional to their respective distances from *y*. Since the magnitude of each force and its moment are each proportional to its distance from the point of rotation, it follows that its moment, or torque, is proportional to the square of this distance; hence torque, or moment, due to spring.

$$A = \frac{a^2}{a^2+b^2+c^2}$$

$$B = \frac{b^2}{a^2+b^2+c^2}$$

$$C = \frac{c^2}{a^2+b^2+c^2}$$

of the total torque WL.

If, however, the reactions *A*, *B* and C be practically rigid in comparison to the beam, which is usually the case, the entire load would be concentrated upon *A* by reason of the beam's deflection.

If the relative elasticities of the

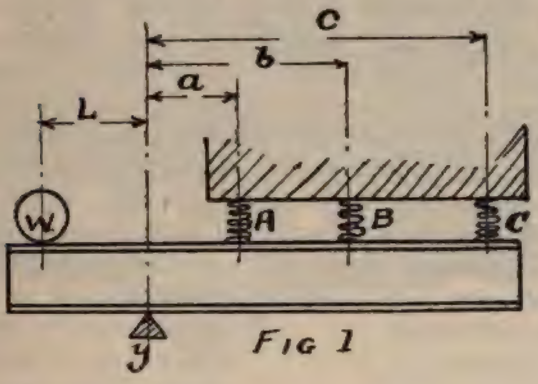
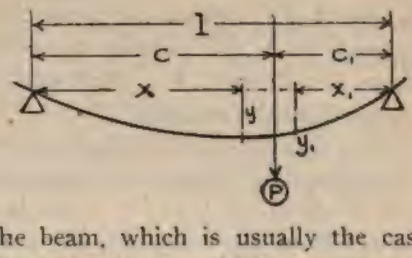


FIG 1



beam and the several reactions be known, their resulting magnitudes, moments, strains, etc., can be determined, but in practice such constructions are usually avoided as inaccuracy of workmanship, unequal settlement, or some other equally practical reason, would usually make the problem undeterminable; in fact, it would be practically so, even assuming theoretical conditions, if the system of loading were at all complicated, as one would have to take into account the elastic curve of the beam; the equation of which, even for a simple beam follows:

$$Y = \frac{p}{j\,e}\,\frac{c^2\,c_1^2}{6\,l}\left\{ 2\,\frac{-}{c} + \frac{x}{c^1} - \frac{x^3}{c^2\,c^1} \right\}$$

$$Y_1 = \frac{p}{j\,e}\,\frac{c^2\,c_1^{\,2}}{6\,l}\left\{ 2\,\frac{x^1}{c^1} + \frac{x^1}{c} - \frac{x_1^{\,3}}{c_1^{\,2}c} \right\}$$

Where I = the movement of inertia of the section and E = the modulus of elasticity.

—*John S. Myers.*

Shafting for Marine Engines.

CARL H. CLARK.

The principles governing the size of shaft for marine work are the same as those well known for stationary power work with the exception that a much larger factor of safety must be allowed since the stresses are less exactly known and far more irregular.

The size of shaft will depend directly upon the horse power transmitted and upon the number of turns per minuet. The general formula for the diameter of a uniformily rotating shaft may be reduced to the form

$$\text{Dia.} = 68.43 \times \sqrt[3]{\frac{\text{h. p.}}{\text{f} \times \text{n}}}$$

where H. P. = the horse power transmitted; N = the number of revolutions per minute; F = the working strength of the material.

The engine shaft is to be figured from the above rule, using, however, .80 or .85 of the I. H. P. as the H. P. transmitted, the remainder being used up in engine friction, etc.

The working stress of the material is about as follows: For compound engines, 3,000; for triple engines, 3,750. These values will be seen to be low corresponding to a factor of safety of nearly 20. This, as said before, is to allow for unknown stresses, and to give sufficient diameter to allow ample bearings. The main bearings are customarily made from 1. to 1.2 x diameter in length, with two to each crank. The crank pins are usually the same diameter as the shaft, and of a length epual to 1. or 1.1 x diameter. The engine or crank shaft may be either of the forged or built up type, the former is mostly used in naval vessels, while the latter is nearly always used in mercantile work, as it is somewhat cheaper and easier to repair. The crank-shaft is made in sections, usually one to each crank. It is of advantage to have these sections interchangeable, as then a single spare section will replace any of the others. The forged crank shaft, as shown in Fig. 1, is usually combined with a hollow shaft, the slabs in this case are from .65 to .70 times the shaft diameter, with a thickness of about 1.1 times diameter of shaft. It will also be noticed that

the corners of the slabs are chamfered off to save some weight without detracting from the strength.

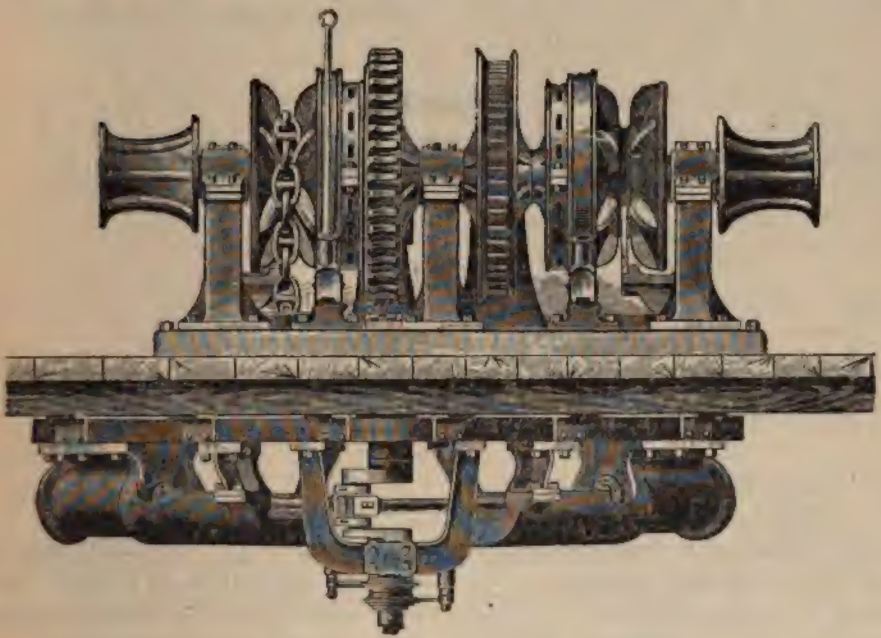
In case of the built-up shaft as Fig. 2, the parts of the shaft and the pins are shrunk and keyed in place; this necessitates that the slabs should be both thicker and wider, thickness being up to .75 of the diameter of shaft, and the width nearly two times the diameter. This construction allows a defective crank pin or portion of shaft to be replaced without discarding the whole section.

The several sections of shaft are fastened together by forged couplings and bolts. The thickness of these couplings is about 3. the shaft diameter, and of sufficient diameter to accommodate the coupling bolts.

The usual diameters of coupling bolts are from 1 1-2 to 3 1-2 inches, and the number from 5 in small shafts to 12 or more in large ones, the between number and diameter of bolts is obtained from the turning movement, as

$$\frac{.196\ D^3}{N \times R}$$

when D = dia. of shaft, N = number of bolts, and R radius of bolt circle. Coupling bolts may be either straight or tapered to about 1-2 inch to the foot, in which latter case no head is required- The threaded part of the bolt may be made smaller than the body, as the nut merely holds the bolt in place. Fig. 3 shows a section through flange.



The thrust shaft is the same diameter as the engine shaft, and is provided with collars to engage the thrust rings.

The area of these collars must be sufficient to keep the thrust pressure down to about 50 lbs. per sq. in.

The line shafting may sometimes be a trifle smaller than the crank-shaft,

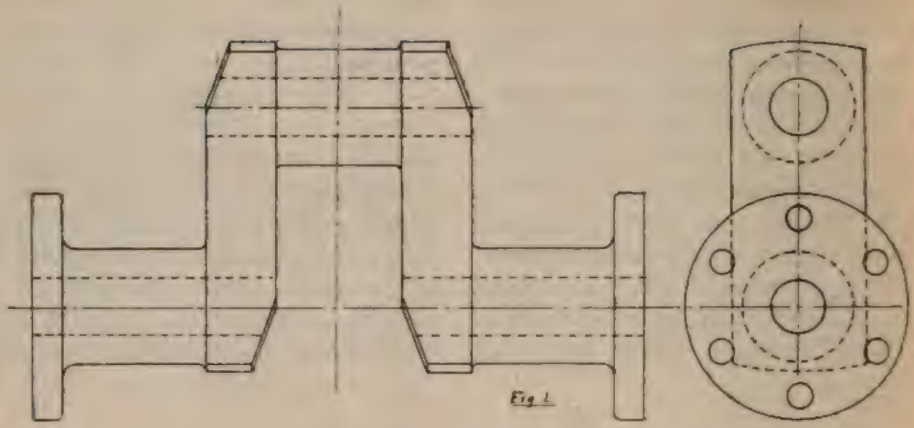


Fig 1

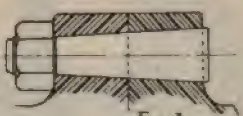


Fig 3

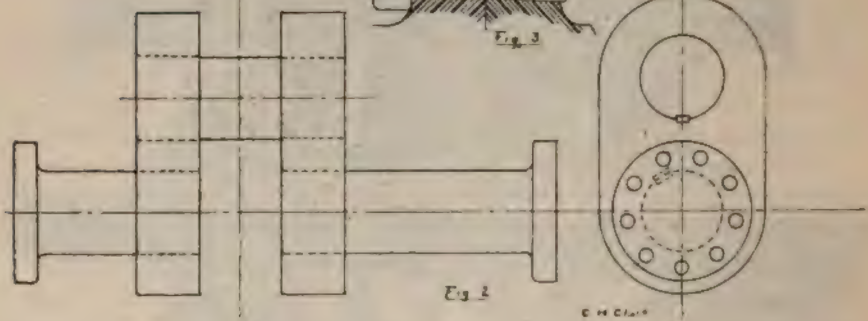


Fig 2

C. H. Clark

as it is subjected to less complicated stresses. The line shafting is supported by steady bearings at short intervals, and is subjected solely to twisting stresses.

The propeller or tail shaft is made larger than the engine shaft, as it is severely strained by the action of the propeller. This increase is sometimes required to be $\frac{1}{50}$. The tail shaft inside the stern tube is covered with some water-excluding material to prevent corrosion by galvanic action.

The entire line of shafting must be made of the very best material, and very carefully inspected during the forging and machining.

First Ocean Turbine Steamer, Victorian.

By Frank C. Perkins.

THE first ocean steamer to be equipped with steam turbines has recently been launched at the Belfast ship yards of Messrs. Workman, Clark & Co. This huge vessel, shown in outline in the illustration, is the Allan liner Victorian. At this launching, 10,000 tons of steel was transferred from land to water, which cost about ¾ of a million dollars. This vessel has very great depth for her beam as is noted when it is stated that it is 74 feet from the keel to her flying bridge. Her total length is 540 feet with a breath of 60 feet. She is divided by bulk heads into 11 compartments and with the subdivisions of her double bottom she has 20 water tight spaces. The three propellers are of manganese bronze, each being operated by a steam turbine at a speed of from 270 to 300 r.p.m. One of the special features of this type of boat is the small propeller and the direct drive by the steam turbines which gives a smooth motion even at very high speed.

This steamer was originally designed to be operated by triple expansion marine engines of the reciprocating type but after the hull was partially constructed it was decided to install the modern steam turbine for the motive power and about this time there was considerable discussion as to whether the steam turbine would be practicable as a means of propelling the great ships that carry the Transatlantic passenger traffic. The keel of the Victorian was laid somewhat less than a year ago and it is expected that before the end of the present year she

SECTIONAL ELEVATION.

PLAN VIEW.

will be ready for sea, when it is certain her trial trip will be watched closely by marine engineers and by many companies which have decided to adopt steam turbines for their new liners. The Parson's steam turbine was the type decided upon, two low pressure turbines and one high pressure turbine being required to operate the three propellers. The high pressure turbine drives the central propeller as in a single screw vessel while the low pressure turbines work the others as arranged in a twin screw steamer. The low pressure turbines are provided with a reversing arrangement which will allow them to be driven at full speed astern either independently or together which will allow the vessel to be easily and effectively manoeuverd backing and turning as readily as with an ordinary twin screw steamer, thus doing away with the objection heretofore urged against steam turbines for driving large vessels, that they were defective in regard to reversing the propellers. These steam turbines are being constructed by Workman, Clark & Co. under an arrangement with Messrs, Parson's & Co. of Newcastle-on-Tyne. The heavy steel casing and drum of each of low pressure turbines weighs nearly 200,000 pounds while the blades both fixed and moving are so small and delicate as to make a remarkable contrast and it seems almost impossible that the steam working on these little blades even in such large numbers can send a great ocean steamer through the sea at a speed of 25 miles per hour but that is what they are expected to do.

The steam for these turbines is to be generated by 8 large boilers constructed at the same works and shops at the Belfast ship yard. The turbine steamer Victorian is intended for first class Canadian mail service and has a capcity for 8000 tons of cargo and possesses accommodations for 1300 passengers with 8 decks, 6 of which are for the use of passengers, her promenades being unusually fine, and the music room, dining room, cabins, and other special accommodation being of the highest grade. The staterooms and other suites of rooms are perfectly ventilated and heated, and the first class smoking room is most luxuriously equipped, while the second class quarters are not less comfortable proportionately, and the third class passengers are catered for in the most liberal manner, electric lights being utilized throughout, a complete printing outfit being provided on board as well as an installation of Marconi wireless telegraphy.

Within a few months the steamer Victorian will have settled the question as to whether steam turbines are successful for ocean liners and are well adapted for these services.

HOME STUDY.

Course II.--Mechanical Drawing.

CHAPTER IV.

Shafting and Forgings.

A large proportion of machine parts are made from metal castings, formed by the aid of a wooden pattern.

Another class of parts is made by forging or rolling from steel or wrought iron billets. Pieces made in this way are used where lightness, toughness and great strength are necessary. They are usually more simple in construction than castings; they are also more costly to manufacture.

Engine crank shafts and connecting rods are familiar examples of machinery forgings. Line shafting is made of rolled steel. In cold rolled shafting the metal is brought to nearly the right size in roughing rolls; it is then run cold, back and forth through finishing rolls until the right diameter is reached.

The effect of this process is to give the shaft a very hard and close-grained "skin" or finish with a soft and flexible core inside.

The so-called structural shapes which are used to some extent in machine design, are formed from the billet by shaping rolls which press the hot metal into the standard shapes, like angles, channels, I beams, and so on.

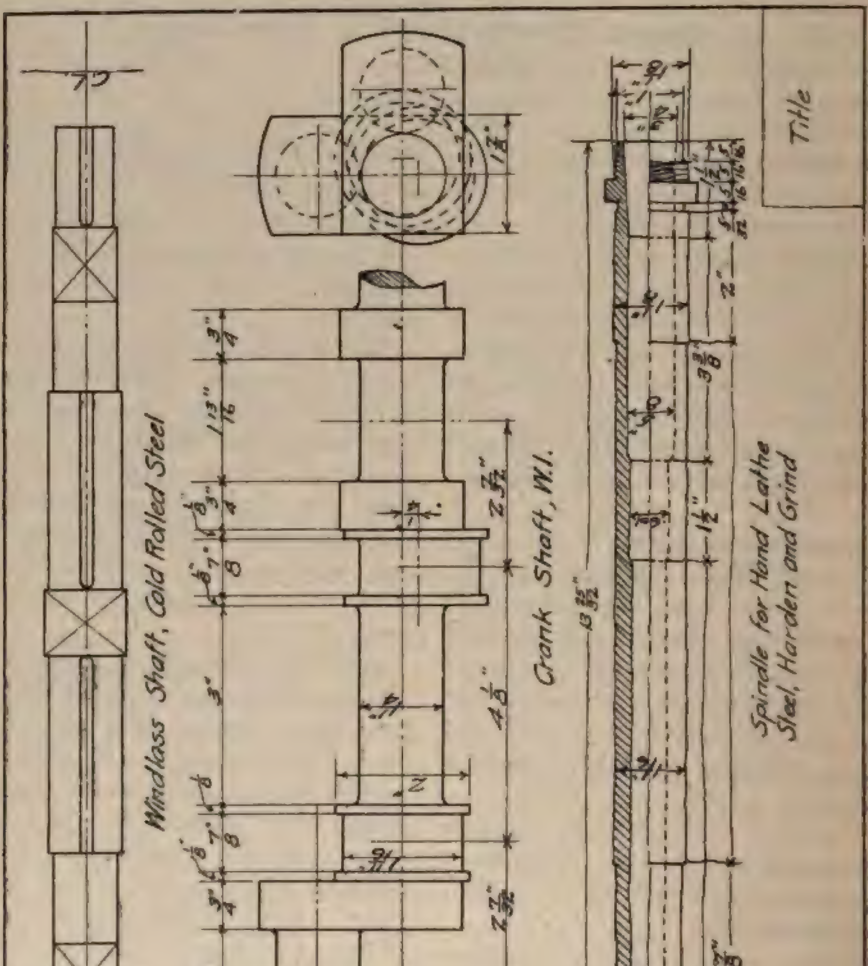
The young draftsman ought to learn these standard shapes and their sizes, so that he can use them readily. The hand books published by the Carnegie, Jones & Laughlins, or Cambria steel companies, contain a great deal of useful information on this subject, and the student is advised to get one of them.

The sketches shown with this chapter all of forgings. In laying out the drawing, first locate the center lines, and be sure that there is room enough for all the views, then lay out the piece from the data given. If there are two views, work them together, for mistakes made in drawing one view will often be found in trying to make the other.

After the lines are all drawn, put the dimensions on in pencil and go over them a second time and check up. This checking is the most important part of making a drawing; it should never be neglected. It is convenient to mark a dimension after it has been checked and proved to be right. Most draftsmen use a small V-shaped mark with pencil or red ink. It is possible then to see at a glance what dimensions have been compared and what have not.

Putting dimensions on a drawing properly is acquired only by practice. Beginners hardly ever get on figures enough. "Does the mechanic need this dimension in order to make the piece?" is the question to be asked in

regard to every figure put on. Put on a dimension for each change of outline. Where there is a row of dimensions the whole length of the object, keep them in line. Then put on an over-all dimension equal to the sum of all the smaller ones. Keep figures outside of the outline of the object as far as possible.



PROBLEM I.

Make a detail of the windlass shaft shown. Make a side and an end view showing the position of keys. The dimensions of the shaft are as follows: 7′ 4″ long over all; 4″ diameter at middle journal. Journals 6″ long, center of middle one in center of shaft; center of end journals 15″ from

end of shaft; diameter of end journals $3\frac{7}{8}$". On each end of the shaft is a drum having a 12"x$3\frac{3}{4}$" bearing. The drum is fastened to the shaft with a gib key of proper dimensions. Inside of and close up to the end journals is a chain wheel having an 8"x$3\frac{7}{8}$" journal. The chain wheel is to have a running fit on the shaft. On each side of the middle journal is a bearing for the worm and ratchet wheels which drive the shaft. Each bearing is 15" long x$3\frac{15}{16}$" diameter, fitted with a key of proper dimensions, and turned to a fit such that the wheels can be forced on by hydraulic pressure. Scale of drawing, 3" to 1'.

The shaft will have to be shown broken in several places to go on the plate. The cut shown on page 446 gives an idea of the machine from which this was taken.

CRANK SHAFT.

PROBLEM II.

Make two views of the engine crank shaft shown in Fig. 2. In the end view, be careful to locate the center of the eccentrics right, with reference to the centers of the cranks. Scale full size.

PROBLEM III.

Lay out to a suitable scale the lathe spindle in the sketch, Fig. 3. Dimension completely, somewhat as shown. Indicate standard threads, and show by notes the kind of fits required. In lettering and figuring drawings, adopt some plain letter and stick to it until a style is acquired. The letter shown is recommended as being about the simplest and most readable.

Strength of Shafting.—From mechanics we know that

$$D=\sqrt[3]{\frac{5.1T}{S}} \quad (1)$$

Also it can be shown that

$$T=\frac{63025\ H.P.}{N} \quad (2)$$

Now if we substitute this value of T in the first formula we get

$$D=\sqrt[3]{\frac{321000\ H.P.}{SN}} \text{ nearly.} \quad (3)$$

We may give S the following values; 45,000 for common turned shafting, 50,000 for soft rolled iron or steel, 65,000 for machinery steel. For line shafts and counters, we should use the first of these values. The second would answer for forged pieces. For places where good wearing qualities or durability is necessary, as for example lathe spindles, use machinery steel. These values represent the ultimate or breaking strength of steel per sq. inch, but no engineer ever thinks of using as high a value as this in practice. It is customary to use factors of safety as follows: Head shafts, 15; line shafts, 10; counter shafts, 6.

A factor of safety is a number by which the breaking strength is divided to obtain the safe strength. Symbols used in this chapter:

T=Twisting moment in lbs. inches.

N=Number of revolutions per min.

$H.P.$=Horsepower.

S=Strength per sq. in. of metal.

d=Diameter of shaft in inches.

D=Diam. of driving pulley or gear.

P=Force applied at rim.

For further discussion of the subject see Benjamin's notes on Machine Design.

QUESTIONS.

1. What is cold rolled steel, and what is it used for?

2. What are the stock sizes of

ordinary shafting from 1" to 4" diameter?

3. About three grades of steel are commonly recognized—hard, mild and soft. State for what purpose you would use each in designing machinery.

4. Can you weld a piece of mushet or stubbs steel? It not, why?

5. Suppose you had to true up the dead center in a lathe, how would you go about it?

6. Describe the process of making drop forgings.

7. Describe briefly the Bessemer process of making steel.

8. How are heavy engine crank shafts made?

9. How much allowance ought to be left for the finish in iron forgings?

10. What is the effect of heat on steel?

11. What would be the cost per foot of the shafting in question?

12. How many horsepower would the windlass shaft in the sketch transmit safely?

13. How many revolutions would the engine have to make in order to transmit 10 H.P.? S = 50,000.

14. How large a shaft would you put in a shop where there was 20 H.P. to transmit and where the shaft made 150 R.P.M.?

15. Describe the Process of rolling steel from the bloom?

MECHANICS.

Work and Power.

CHAPTER IV.

WHEN anything exerting a force produces any effect on a body, and the object acted upon moves in the direction of the force, then the thing exerting the force is said to *do work*.

For example, a man does work in lifting a pail of water; gravity does work on the weight of a pile driver, causing it to descend when released; the electric current by means of the motor, does work when it runs the elevator and thus lifts a weight through space.

Unless the object moves in the direction of the force, no work is done no matter how great the force may be, hence we may consider *work* as the overcoming of resistance, and the amount of work done is measured by the resistance overcome, multiplied by the distance through which it is moved. Then the work done is not measured by the amount of resistance or the distance moved, but by the product of the two, which is called the unit of work.

There are three units of work in common use:—

(1) The *foot-pound*, or the work done by a force of one pound working through a space of one foot. It is the unit most used by English-speaking engineers, but it is open to the objection that it is variable, on account of the variation of the weight of a pound with the latitude.

(2) The *Kilogramme-meter*, or the work done by a force of one kilogramme working through a distance of one meter. This is the unit of work in the metric system, and is

[illegible]

6. In a town of 15,000 inhabitants, each person uses water at the rate of 50 gals. per day. If the water has to be pumped to a height of 200 feet, what is the horse-power of the pump?

7. A man whose weight is 160 lbs. carries 60 lbs. on his back and climbs a ladder to a height of 40 ft. in 1 1-2 minutes. Find first his power in ft. lbs., second, as a fraction of a horse-power, and third in watts.

8. At what rate is an engine working which raises 2,000 tons of coal per day from a pit 250 ft. deep?

9. A tank of 1,000 gal. at an elevation of 50 ft. is filled with water in two hours by a pump. Calculate the horse power.

10. Measure up some engine that you have access to and calculate the horse power. (Class room engine to run at 200 revolutions, with mean effective pressure of 50 pounds per sq. inch.

Questions.

1. Find the proper thickness of a cast iron water pipe 6" in diameter. s=18,000 factor of safety 6. Pressure 200 lbs. per square inch. Does this result agree with practice? Why?

2. A standard lap welded steam pipe 8" inside diameter is .32" thick. It is tested to an internal pressure of 500 lbs. per sq. in. Find the bursting pressure and the factor of safety above the test pressure. s=40,000.

3. Calculate the thickness of the following size of pipe and compare with amounts given in the tables of pipe sizes. (Kent, page 194.) Use formula given in this chapter.

2" pipe nominal inside diameter.

3" pipe nominal inside diameter.

4" pipe nominal inside diameter.

5. If one square foot of radiating surface is required for each 75 cubic feet of space in a room, find how large a room can be efficiently heated by any (See Kent, p. 537.)

Note.—The area of the outside of the pipe is used in calculating the radiating surface.

2. Find the weight of an oak beam 6"x8" in section and 13' long. Of a steel bar 1" in diameter and 13 feet long. Of sandstone, 18"x24"x9'

10" pipe nominal inside diameter.

4. Estimate the weight and cost of the piping system shown on the sketch to be furnished by the instructor. (For the "Home Study" department any system will answer. Piping lay outs are frequently published in the technical magazines.)

New Building Stone.

The firm of Jencqual & Hayn, of Hamburg, Germany, have patented a process for manufacturing an artificial building stone from infusorial earth, which they call guhrolit. This stone is very light, is fireproof, withstands the influence of most chemicals and can be easily sawed, nailed, and bored.—Walter Schumann, Consul Mainz, Germany.

Current Topics.

Civil Service Examinations.

The United States Civil Service Commission announces an examination on January 4, 1905, to secure men to fill vacancies in the positions of foreman of diamond drill boring party, foreman of wash boring party, and boring party helper; also assistant foreman, foreman and general foreman of laborers.

On January 18, 1905, there is to be an examination for clerk, bookkeeper, timekeeper, surgeon, physician, pharmacist, hospital interne, trained nurse, assistant civil engineer, instrument man, transit man, level man, rod man, chain man and helper.

All positions are on the Isthmus of Panama under the Isthmian Canal Commission, and the examinations are to be held at a large number of places.

For details address U. S. Civil Service Commission, Washington, D. C.

Various Forms of Tracing Paper.

An invention which has for its object the rendering more or less transparent of paper used for writing or drawing, either with ink, pencil or crayon, and also to give the paper such a surface that such writing or drawing may be completely removed by washing, without in any way injuring the paper, was patented some time ago. The object of making the paper transparent is that when used in schools the scholars can trace the copy, and thus become proficient in the formation of letter without the explanation usually necessary; and it may also be used in any place where tracings may be required, as by laying the paper over the object to be copied it can plainly be seen. Writing paper is used by preference, its preparation consisting in first saturating it with benzine, and then immediately coating the paper with a suitable rapidly-drying varnish before the benzine can evaporate. The application of varnish is by preference made by plunging the papers into a bath of it, but it may be applied with a brush or sponge. The varnish is prepared of the following ingredients: Boiled bleached linseed oil, twenty pounds; lead shavings, one pound; oxide of zinc, five pounds; Venetian turpentine, one-half pound; mix and boil five hours. After cooling, strain, and add five pounds white copal, six and a half pounds sandarac.

The following is a capital method of preparing tracing paper for architectural or engineering tracings: Take common tissue or cap paper, any size sheet, lay each sheet on a flat surface

and sponge over (one side) with the following, taking care not to miss any part of the surface : Canadian balsam, two pints ; spirits of turpentine, three pints ; to which add a few drops of old nut oil ; a sponge is the best instrument for applying the mixture, which should be used warm. As each sheet is prepared it should be hung up to dry over two cords stretched tightly and parallel, about eight inches apart, to prevent the lower edges of the paper from coming in contact. As soon as dry, the sheets should be carefully rolled on straight and smooth rollers covered with paper, about two inches in diameter. The sheets will be dry when no stickiness can be felt. A little practice will enable any one to make good tracing paper in this way at a moderate rate. The composition gives the substance to the tissue paper.

You may make paper sufficiently transparent for tracing by saturating it with spirits of turpentine or benzoline. As long as the paper continues to be moistened with either of these you can carry on your tracing ; when the spirit has evaporated the paper will be opaque. Ink or water colors may be used on the surface without running.

A convenient method for rendering ordinary drawing paper transparent for the purpose of making tracings and of removing its transparency, so as to restore its former appearance when the drawing is completed, has been invented by M. Puschers. It consists in dissolving a given quantity of castor oil in one, two or three volumes of absolute alcohol, according to the thickness of the paper, and applying it by means of a sponge. The alcohol evaporates in a few minutes, and the tracing paper is dry and ready for immediate use. The drawing or tracing can be made either with lead pencil or India ink, and the oil removed from the paper by immersing it in absolute alcohol, thus restoring its original opacity. The alcohol employed in removing the first oil is, of course, preserved for diluting the oil used in preparing the next sheet.

Put one-quarter ounce gum mastic into a bottle holding six ounces best spirits of turpentine, shaking it up day by day ; when thoroughly dissolved it is ready for use. It can be made thinner at any time by adding more turps. Then take some sheets of the best quality of tissue paper, open them, and apply the mixture with a broad brush. Hang up to dry.

Corbon tracing paper is prepared by rubbing into a tissue a mixture of six parts lard, one of beeswax, and sufficient fine lampblack to give it a good color. The mixture should be warm, and not applied in excess.

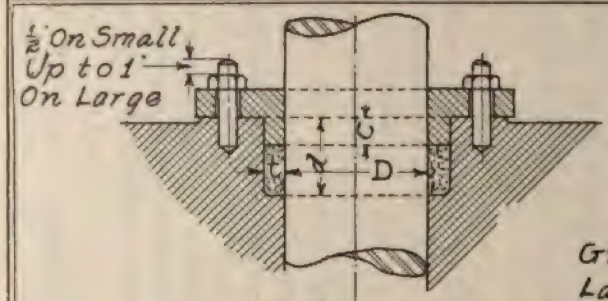
Sa urate ordinary writing paper with petroleum and wipe the surface dry.

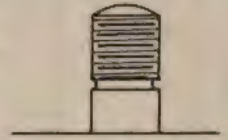
Lay a sheet of fine white wove tissue paper on a clean board, brush it softly on both sides with a solution of beeswax in spirits of turpentine (say about one-half ounce in half pint), and hang up to dry for a few days out of the dust.—*National Builder*.

The Need of Shop Training

[illegible]

VARIOUS HYDRAULIC PACKINGS & JOINTS.

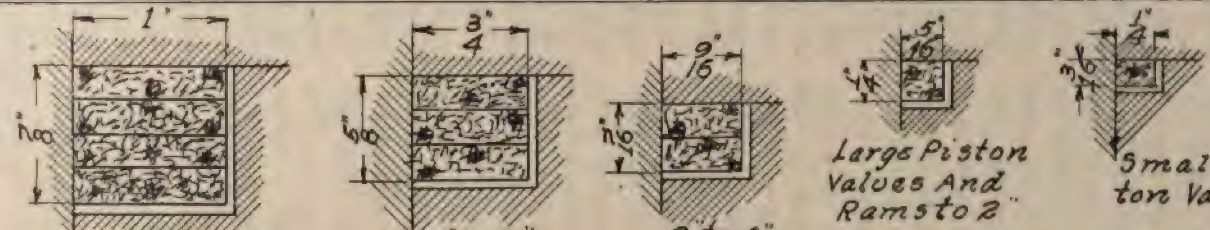




Groove Stud on Large Rams. Allow 5000# Stress In Studs At Root Resulting from Annular Space X Pressure.

D	1-1½	1½-3	3-5	5-8	8-12	12-20	20-24
t	¼	⅜	½	⅝	¾	⅞	1
c	⅜	½	¾	1	1¼	1½	1¾
d	2	3	4	5	6	7	8

Glands are Screwed Home When Packed.



Rams Above 8" — 4" to 8" — 2" to 4" — Large Piston Valves And Rams to 2" — Small Piston Valves.

Cylinder Packing Turned To Fit Cyl. Ram Packing Bored To Fit Ram. All Other parts Left Rough

Leathers are specially selected Hide Of Uniform Thickness Of About 3/16". Selected as Solid as Possible And After Being Prepared Is Soaked In Melted Parafine. Multiple Leathers Are Stitched Together. Has Proven Entirely Satisfactory On 4000# ☐" And Has been Occassionaly Used On 6000# Pressure.

The Beginnings of A B C.

How did men first come to invent their A B C? Whence did the familiar letters arise? In half a century—between the edition of the "Encyclopædia Britannica" of 1853 and the *new* (not the *old*) volumes of the *Times* edition—three sets of answers have been given. The third time is lucky! In 1853 the writer in the "Encyclopædia" on the alphabet kindly offered us a choice of three theories: 1. Adam invented letters. 2. Letters have existed from all eternity. 3. They came by divine revelation—to somebody unnamed. This lacks common sense!

Next, if you look up "alphabet" in the *old* volume of the *Times* edition (1875), you will find something more sensible, but almost wholly erroneous. The letters, we learn, came thus: First, savages design pictures representing a series of events, and draw them in skeleton outlines, like "Tommy Traddles," in "David Copperfield." To take a red Indian example, you scratch twenty-three erect strokes on a bit of birch bark; that means twenty-three braves. Then you draw a bottle-nosed face, with short hair stricking up all around it, head, cheeks and chin. That is the sun. Below it you put ten horizontal strokes; this means that the twenty-three warriors were for ten suns, or days, on the warpath. You next sketch three rude ground plans of forts; this means that three English forts were attacked. You put in ten isosceles triangles reversed, with their limbs produced from the apex. This means ten men lost to his Britanic Majesty's forces. On the bases of four of the ten triangles are dots. This means that four of the ten English soldiers have kept their heads on, and are living prisoners. You now draw a tortoise in one corner; this may be the signature of the writer, a man of the tortoise totem; or it may symbolize land, and mean "all right."

This process is pure "picture writing."

You can understand it without knowing the Choctaw language.

The next step is to draw real objects with a symbolical meaning: a picture of a pipe stands for peace, of a bird on the wing for "hurry up," of a fire for a family. A tract printed for the conversion of the Mikmak Indians needed 5,701 of these characters, and the results perhaps did not justify the outlay.

The next step toward the alphabet is to draw pictures which represent the sounds of words. To make "buoyant" (sounds *boyant*) you design a skeleton figure of a boy, and another of an elderly lady, his aunt. There was a Mexican king called Itzcoatl, from *itz* (a knife) and *coatl* (a serpent). His name was written with pictures of several knives on the back of a snake.

By these steps we reach ancient Egyptian hieroglyphs. The Egyptian word for an owl was *mulak*. First an owl was represented, cut on stone, an unmistakable owl. Next, the owl picture stood for the syllable, or sound, *mu*, the first syllable of *mulak*. Next, the owl picture means only M.

cient seals of the Greek islands, and he concluded that there was writing before the Phœnicians invented our alphabet. He discovered many more such seals in Crete, and, at last, dug up whole libraries of clay tablets, with writing in lines, "linear writing," all very much older than Phœnician trade. He also found most of the Greek letters engraved on bone fishes, perhaps counters in a game, one letter on each fish. We do not know what the very early Egyptian meant by the characters so like our own letters. We do not know what the Clydesdale people meant by several of the same characters on their slate amulets. I ought to say that the gentlemen who found them (Mr. W. A. Donnelly and Mr. John Bruce), never said anything about these characters, nor did those who called the things forgeries. I only happened in December, 1903, to notice the Egyptian resemblances. However, Mr. Evans' Cretan finds certainly were covered with real writing, long before the Phœnicians' "invention" of the alphabet. On a Cretan seal of perhaps 2,500 B. C. he found two characters. In Greek they would read (in our letters) U over P and the same U over P come on a slate amulet discovered in the Clyde! This must probably be a mere chance coincidence, but it is odd. In some of Mr. Evans' seals you see rude skeleton pictures turning into letters, but one bears the monogram K M and the other the monogram W P, if read as our own letters; also there is M D in a monogram. On one broken stone table Mr. Evans found that, out of four characters three tallied with old Greek forms, though a thousand years earlier than the oldest known Phœnician (or, rather, Semitic) inscriptions. Three also appear in Libya, on the southern side of the Mediterranean.

What is perhaps still less expected, the greater part of the alphabet turns up in regular inscriptions from stones above tombs, in Spain and Portugal, the X being the same as the red Indian figure that represents a man with his head off. These tombs are prehistoric, and earlier than Phœnician trade in Spain. Nobody doubts that these Spanish and Portuguese letterings on tombs—epitaphs, in short—are genuine. They are written between horizontal incised lines, as children are taught to write on ruled paper.

Next, similar characters, thirty-four in all, were found on various small tablets of stone, under a dolmen, or artificial chamber of gigantic unhewn slabs of rock, in Portugal, in 1895. The A lies on his left side, like the Phœnician *Aleph*. The Greek U, K, L, M, N, H, Ps, D, I, E, and other characters, can be recognized by a child. Now these dolmens were raised by people who have left no metal implements, only knives of hard stone and axes of the same, with minute fragments of the rudest pottery. It should follow that alphabetic characters (whatever their meaning may have been) were well known to people in Portugal thousands of years before the Phœnician sailed to the pillars of Hercules, and "Sly traffickers, the dark Iberians came."

But the alphabetic marks were found with a cartload of little stone female idols, stones marked with small, round cups, stones scratched

[illegible]

[illegible]

[illegible]

[illegible]

Hot Air.

The following is part of an article seen in a local newspaper: "Laisy's airship is unique in construction. The gas bag is forty feet long, eighteen feet in diameter, and forty feet in circumference, and holds when inflated. 20. 000 cubic feet of gas. A central beam runs through the gas bag. This bag is intented to turn around and around and with the aid of queer looking contrivances on the sides to rush through space. The inventor says the principle is much the same as that of an auger in motion."

To the average reader the dimensions given would appear all right, but on second thought many of these readers would notice something wrong with the figures. Do you?

First, the bag could not be 40 feet in circumference and 18 feet in diameter for 18′ x 3.1416=56. 54 feet circumference and if 40 ft. in circumference it would only be 12′ 9″ in diam.

Second, if it was 18 ft. in diameter, 40 ft. long and spherical on the ends it would hold only 8650.23 cu. feet of gas and if only 40 ft. in circnmferance it would hold only 4565 cu. ft. of gas, hence we say, "Too much hot air," and this often occurs in newspaper reports of mechanical appliances.

Book Notices.

The Up-to-Date Hardwood Finishers, by Fred T. Hodgson. 200 pages 5x8. Fully Illustrated. Cloth bound. Price $1.00. Frederick J. Drake & Co. Publishers. Chicago, Ill.

The book is arranged in two parts, the first devoted Wood,s tools and the second to coatings, fillers and finishing.

The description of woods for hard wood finishing is very complete and is conclude l with explanations of the manner of putting them together.

The knowledge of the kind and care of tools for this work is a matter well worth the study of the woodworker and being well illustrate.l will .e much value to him.

Part two is con'ne' to the manners of finishing woods with fillers and gives many receipts an.l instructions that are very practical.

Different colors of stainin, ebonizing, polishing and the particular manner of treating various woods is here discussed together with the many tools and brushes.

Wire and Wireless Telegraphy by E. B. Moore. This is one of the latest and most popular books published. In this little volume the author endeavors to give a brief bnt intelligible and connected description of the science and history of the electric telegraph, practical applications and a brief sketch of the developments.

Much care has been taken in preparing the chapters in the latter part of the book which give a very good idea to the reader of the present systems and stations of wireless telegraph.

It is written in good, plain language so that the amateur may readily understand and comprehend it, also the professional may find it interesting and to contain many good points well worth notice.

Mail 50 cts. to E. B. Moore, Springfield, Vt., and receive by return mail one (1) copy of this latest book, Wire and Wireless Telegraphy, which has just been published.

Remittance may be made by money order if desirable. Postage stamps accepted. Mentiou The Draftsman.

The DRAFTSMAN.

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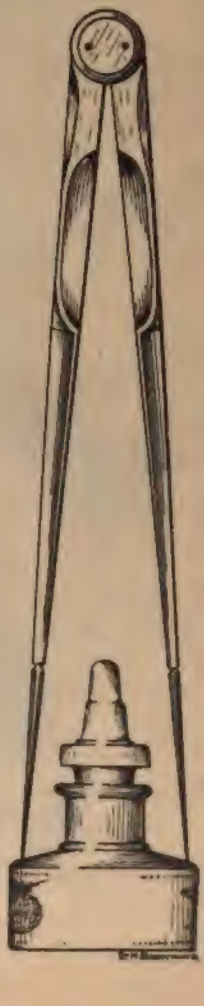

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MECHANICS.

Steam Turbines

By Robert G. Griswold.

DOES it not seem strange that the progress in practical steam engineering has been marked by the development of almost every detail connected with the generation of steam, save the reciprocating steam engine. Is this true because Watt studied carefully every possible design that could have been used, or was it entirely an accident? However, the fact still remains that the reciprocating engine has heretofore defeated all new-comers in the field of prime movers. In mechanical details, it might be simplified to some extent, but not to such an extent that any gain in efficiency would be obtained.

We have practically reached the hill-top in the manufacture of frictionless bearing metals, lubricating oils and steam packing for high steam pressures, so little gain can be looked for in this direction. But on the other hand, we are developing new boilers that are giving us higher steam pressures, and also superheated steam; the latest forms of water-tube boilers are highly efficient compared with the old forms of fire-tube boilers of a few years ago.

The steam pressures generated to day have placed before the boilermakers specifications that a few years ago would have been considered impractical, but they have responded to the demand in an admirable way, giving us safe generators which are in most cases durable. And it is reasonable to suppose that we have not yet attained the limit of working pressures for this composite type.

But has the steam engine kept pace with this development in the steam generators? Are we not constantly arguing the relative merits of the compound, triple and quadruple expansion engines? And are we not still juggling with logarithmic exponents to gain a point here and another there in the ratio of expan-

brought down within practical limits for dynamo work. For marine work it is yet too great, for the slowest turbine has a much higher number of revolutions than the highest speed reciprocating engine.

It may be well to give a more detailed description of the workings of a Parsons turbine, aided by a few sketches:

The steam enters an annular chamber surrounding the shaft at boiler pressure. From here it flows in a direction parallel to the shaft through a series of rings of vanes and guide blades to a large chamber, expanding gradually from ring to ring, finally passing out to the condenser. In Fig. 1 is shown an expanded view of the positions of the moving and stationary blades or vanes. The vanes of rows AAA are so bent that the steam is made to flow in a right-handed direction about the shaft, while the vanes in the rows BBB are bent so that this direction is reversed. It is readily seen therefore that as the steam enters the first row of vanes it is given a motion that tends to make it revolve about the shaft in a right-handed direction, but it has no sooner received this direction than it meets with the vanes on the movable drum which tend to change its direction and make it travel in the opposite direction. The stationary blades resist the impact of the steam, but the movable blades impart this impact to the drum which causes it to turn, and since the thrust imparted to these blades is almost tangential to their circular path, the power developed by the turbine is practically the sum of these impulses. It can be readily seen that the steam turbine is in reality a multiple expansion engine, but without the intervention of two or three receivers where loss of efficiency can be had.

Prof. Thurston in writing on the steam turbine makes the following statements in effect:

1. If we consider the steam turbine thermo-dynamically, it very closely approximates the ideal heat motor.

2. It is superior to other types of heat motors since it is entirely free from steam wastes.

3. It is an ideal type to use with the modern high pressure steam.

4. Its limit of rotative speed is only limited by the strength of the materials of construction that are necessarily used in its construction.

5. Since there are no rubbing parts, other than the bearings, it readily allows the use of super-heated steam, which is practically precluded in other types owing to the necessity for the use of lubricating oil on the rubbing surfaces.

6. The main wastes of the steam turbine are all outside the steam line, and comprise the journal friction, fluid friction between the disc and enclosing vapor, leakage, incomplete expansion, and certain thermo-dynamical wastes which may be eliminated, as there are so many other advantages to counterbalance them.

Its principal disadvantages are, for marine work, irreversibility, low efficiency at low speeds, and excessive cost.

The outward appearance of a turbine shell would indicate that the expansion took place in three or more decided steps, but the cross-sectional area of the passages between the vanes is increased many times in many small steps, thus giving a gradual expansion throughout the length of the drum. In a certain plant consisting of three 500 h.p. turbines, which run at 3,600 revolutions per minute, the ratio of expansion between the inlet and outlet is in the proportion of 96 to 1; the drum has 58 rows of vanes.

It is not to be supposed that there are no mechanical difficulties to be overcome in the construction of this simple machine. It is necessary to overcome and counteract the end thrust due to the axial impact of the steam on the moving blades; a perfect balance must be secured in the rotating parts of the machine, for at such high speeds they would soon rack themselves to pieces; the lubrication of the shafts presents no slight difficulty, and the governing of the machine for variations of load is by no means easily accomplished.

It may be interesting to note the wording of Mr. Parsons' claim in his patent papers:

"Now, according to my invention, to obtain a low effluent or terminal pressure while using a comparatively high initial pressure, I use a compound motor or combination of motors so arranged that the same actuating fluid operates therein in a suceessive manner, undergoing expansion and falling in pressure in each until it leaves the last at a velocity not greatly above that which is practically attainable by the motor itself. By this arrangement each motor or successive portion of the compound motor utilizes a portion of the energy of the fluid, and thus instead of the greater part being wasted, as heretofore, it is successively drawn upon until a comparatively high efficiency is obtained."

This marks the essential difference between the Parsons type and that of DeLaval, as in the latter type it is not possible to make the peripheral speed of the rotating member approach as closely that of the terminal speed of the steam as can be done in the Parsons.

A sketch is given herewith showing the Parsons turbine in section. This is not, however, the particular type spoken of above, but will serve to show the action very clearly. The steam enters the annular space G, and travels towards each end of the motor, passing through the intervening series of fixed and movable vanes, the former being fixed to the casing C, and the movable vanes, bb_1b_2 being fixed to the drum mounted on the shaft s. It then passes to the exhaust nozzle h_1 through the passages hhhh and down under the casing. If close examination is made it will be noticed that where the steam enters, the blades are comparatively shallow, increasing in depth by sets to the ends. It will also

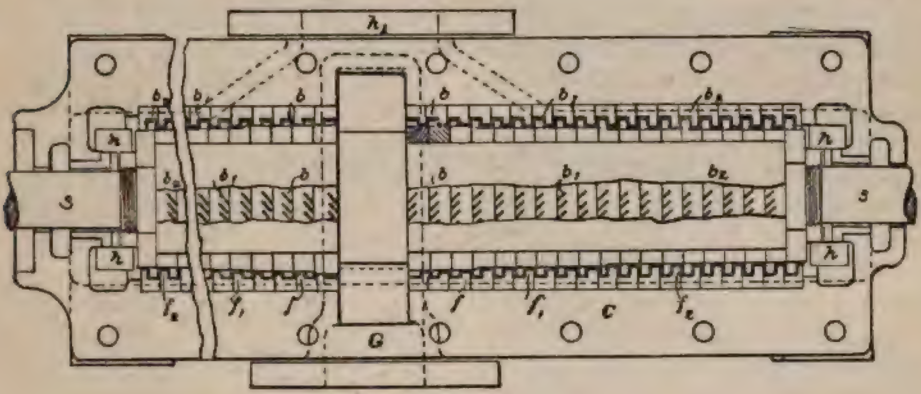


Fig. 2.

be seen that where the steam enters the blades are set at a greater angle than where it exhausts. This causes the steam to meet, as its pressure decreases, with sets of blades of increased area and pitch, the increase being so calculated that the velocity of the stream shall be suitable to that set of blades between which it passes, and by these means the gradations of pressure are governed. The passage of the steam from the middle towards the ends will impart to the shaft and drum rapid rotary motion.

Since it is almost a mechanical impossibility to make the center of gravity of such a mass coincide exactly with the center of rotation, the bearings are made with a slight play in order that the revolving mass may settle with its center of gravity coinciding with that of rotation. In Fig. 3 is given a general plan of the method used to accomplish this end. There is a light bushing, *i*, outside of which are placed metal rings or washers, *kkl*. The alternate washers, *k*, are slightly larger than *kl* in diameter, so that the alternate washers *k* fit the casing but not the bushing, while the washers, *kl*, fit the bushing but not the casing. The bushing now allows of a slight lateral movement, but is resisted by the pressure of the spring at the end which causes friction between the washers.

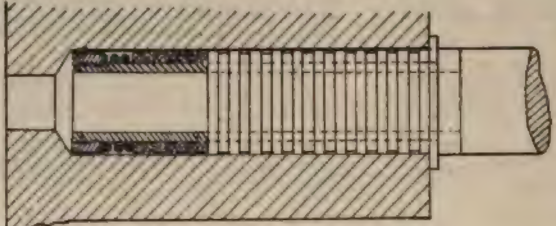


Fig 3.

The governing of the speed is accomplished by means of a ball governor which admits steam to a small cylinder, which in turn actuates a still larger cylinder operating the throttle valve. This admits the steam to the turbine in gusts, as it were; while running at full load the throttle will be wide open most of the time, closed mostly at no load, and opening and closing alternately as the loads are thrown on or off or rapidly changed.

Since the original design great improvements have been made in the structure of the machine. Originally the vanes were milled from solid metal, but they are now wrought from a special brass and keyed into a dovetailed slot in the drum, which makes them secure and trustworthy, and there is little fear of one breaking off and ruining the machine as was often the case with the solid milled blades.

STRUCTURAL.

Sustaining Power of Beams.

E. G. Stone.

IN all lines of construction work, whether boiler, bridge or building, it frequently happens that much depends upon the load which a beam will carry, and this article is written for the assistance of those who come in contact with this problem, and wish to know something of the methods for arriving at a knowledge of the sustaining power of a beam under different loads and distribution of loads.

While a loaded beam is subject to shearing strains, these are very easily calculated and are very rarely considered as a possible cause of failure. We will spend but little time considering them, and will concentrate our attention on the methods for calculating what is known as the bending moment, for it is this that causes failure in almost every case.

Two general cases present themselves. The first is where a beam is set solidly in the wall at one end only, as in Fig. 1, and the second is where it is supported at both ends, as in Fig. 2. We will first consider the case of Fig. 1, where but one end of the beam is supported, and where the weight is applied at the extreme end away from the support. In this case the maximum bending moment is located at the point of support, that is just where the beam enters the wall, and it is here that failure is most liable to occur. This bending moment is measured by the product of the weight, by the distance from the wall, which is marked "a" in the cut.

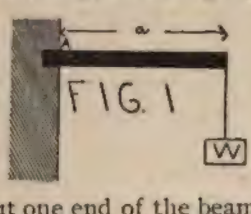


FIG. 1

The weight is usually taken in pounds and the distance in feet. Thus if the distance "a" is 6 feet and the weight "W" 25 pounds, the bending moment at the point A is $25 \times 6 = 150$ pounds-feet. If in this case the weight is uniformly distributed, as, for instance, the weight of the beam itself, it may be taken as if located at its center.

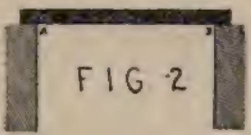


FIG 2

Suppose the weight "W" in Fig. 1 is evenly distributed over the length of the beam as in Fig. 3. Then we may consider the whole weight as if all located at its center, and to get the maximum bending moment, which is, as before, at the point A, we multiply the weight "W" by the distance to its center of gravity $\frac{1}{2}$a. In other words, a beam loaded with a uniformly distributed load, as in Fig. 3, will support twice the load it will when the load is all placed at the extreme end, as in Fig. 1.

The same general method applies to loads distributed in any manner on a beam with but one support. The maxi-

mum bending moment is always at the point of support, that is at the point A, and is equal to the sum of each of the weights on the beam multiplied by their distances from A. Thus, if a beam is loaded, as in Fig. 4, with three weights, one of 5 pounds at a distance of 2 feet, another of 3 pounds at 5 feet and another of 7 pounds at 7 feet, then the bending moment at the point A, which is the maximum, is the sum of all these products, that is $(5\times2)+(3\times5)+(7\times7)$, which equals $10+15+49=74$ pounds-feet.

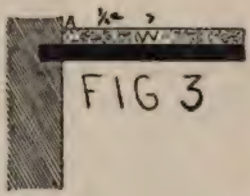


FIG 3

There is a shearing strain in Figs. 1, 3 and 4 equal to the total weights, including the weight of the beam itself. Neglecting the weight of the beam, which is not given, there is a total shearing strain at the point A in the problem in Fig. 4 of $5+3+7=15$ pounds. The shearing strain is always a maximum at one of the points of support, and is equal to the amount of weight supported at that point. If there is but one point of support there is no question of where the maximum shearing strain is and what it amounts to, as all of the weight is supported there. By dividing this total shearing strain by the sectional area of the beam the shearing strain per square inch can be arrived at and the possibility of failure from this cause noted.

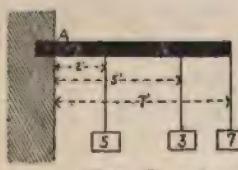


FIG. 4

We now come to the consideration of the case where the beam is supported at both ends, as in Fig. 2. The first thing to do in this problem is to find how the weight is distributed between the two supports. Starting at either end, as, for instance, A Fig. 2, take every weight on the beam and multiply it by its distance from this end (A) and add these products together. Divide this sum by the distance between the supports AB and the results will be the weight supported by the end B; that is, the end opposite to that from which the start was made. A distributed weight may be considered to be entirely located at its center of gravity. Such a load is the weight of the beam itself, which, if the beam is uniform, will be evenly divided between the two supports because its center of gravity is half way between them.

To find the weight which is supported by the end A we might proceed as we did in finding the weight supported at B, only the rule is reversed in this, that instead of starting at the end A, we start at the end B, multiply every weight by its distance from B, summing up these products and finally dividing by the distance between supports to find the weight supported at the end A, opposite to the one from which we started. By far the easier way, however, after having found the weight supported by one end, is to subtract that from the total load on the beam, which will naturally leave the portion supported by the other end.

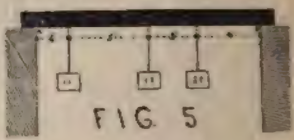


FIG. 5

As an example let us take the arrangement shown in Fig. 5. Starting at the end A we first come to the weight 11 pounds, at a distance of 2 feet; next to a weight of 17 pounds at a distance of 7 feet, and last to a weight of 21 pounds at a distance of 10 feet. $11\times2=22$, $17\times7=119$, $21\times10=210$. $22+119+210=351$.

[illegible]

[illegible]

of this 17-pound weight belongs to B and must not be considered when we are calculating the bending moment by multiplying the weights supported at A by their distance from A. Hence our first product is 22 (11×2) and our second is 91 (13×7). Adding these two together gives us 113 ($91+22=113$), which is the maximum bending moment of the beam in pounds-feet.

Starting from the end B we first come to a 21-pound weight at a distance of 4 feet, and next to the 4 pounds (part of the 17-pound weight) at a distance of 7 feet. The bending moment calculated from this is $(21\times4)+(4\times7)=84+28=112$, which agrees practically with that calculated by starting from the end A. If we had not neglected some fractions the results would have been identical.

In all calculations which we have made, with but a single exception, which we will now note, any distributed weight may, for the purposes of calculation, be considered as if entirely collected at a single point and that point is the center of gravity of that distributed weight. The exception we referred to applies to but a single operation; that is, the final operation, just described, in calculating the maximum bending moment of a beam supported at both ends. In this operation the only case where a distributed weight cannot be treated as if entirely collected at its center of gravity, is where the dividing line cuts it into two portions. In this case each portion is supported by a different end of the beam, and each portion must be considered as having a center of gravity of its own for the purpose of calculating the bending moment. Such a division is not necessary in calculating the distribution of the weight between the supports. In fact, it is not until after this calculation has been made that the position of the dividing line is known, and consequently any division of weight depending upon the position of the dividing line is impossible until after this calculation has been made.

The shearing strain in a beam supported at both ends is maximum at the point of support which sustains the largest portion of the total load, and is equal to the load supported there. Thus, in Fig. 5 the total shearing strain at A is 24 pounds and at B 25 pounds. By dividing by the sectional area of the beam in square inches the shearing strain per square inch may be arrived at.

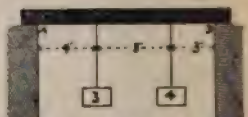


FIG 6

The above are the general methods for calculating the maximum bending moment under any conditions, but special rules often expedite the calculations, and we will now consider some of these special cases.

The most usual case is what is known as the symmetrical load. This may consist of any or all of the following three: First, a load placed at the center of the beam; second, a load uniformly distributed over the entire length of the beam, and, third, pairs of equal loads so placed that one is the same distance from one end of the beam as the other weight is from the other end. The dividing line and consequently the maximum bending moment of a symmetrical load is the center half way between supports, dividing any weight which my be located there into two even portions. The maximum bending moment may be calculated by taking one-half of the beam, multiplying every weight on that half and the half of the center weight, if there be one, by their distances from their support.

Another common case is where but a single weight is supported by the beam.

The maximum bending moment is located under the weight and is equal to the weight multiplied by the product of its distances from both supports and divided by the total distance between supports. This may be easily proven by rules previously given.

Many manufacturers publish tables showing the sustaining power of beams. These generally show the weight which different beams will support for different spans when the load is distributed uniformly over the whole length of the beam. The principles given here, for which we are indebted to *Motive Power*, will show how much more or less a beam will sustain when the load is distributed in any manner whatever. — *Ryerson's Monthly*.

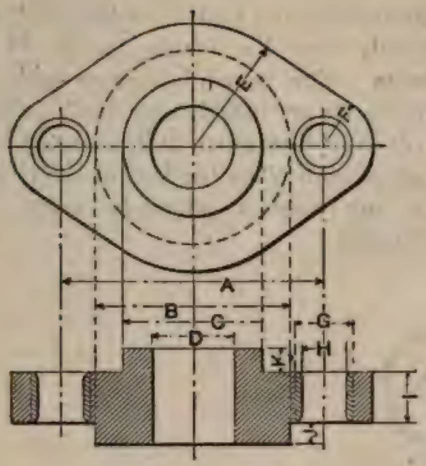
Labor-Saving Scheme for Making Drawings.

A WRITER in *Machinery*, Mr. H. A. Houghton, says:

"In Mr. C. W. Putnam's article, "Labor-Saving Scheme for Making Drawings," in the September number of *Machinery*, I do not think he has chosen a very good illustration of the use of templates in the drawing-room. He was obliged to make a pencil drawing in the first place. Then, while he was cutting out the template, he could have put a piece of tracing cloth over it and traced it, or this would have been a good job for the blueprint boy. Letters would then have been put on for dimensions, and while he was packing up his five sheets of tracing paper with the carbon sheets between, a row of columns could have been ruled off under the figure. At the head of the first column could be put "No. of Gland," and the letters corresponding to the dimensions at the heads of the others. He would then have something permanent, and it would have taken little longer, if any, than for him to make his first five copies. It will take no longer to fill in the dimensions for the different size glands on the tracing than it would on his sketches, and if he printed the same title, as shown, on each sheet, he would be left far in the rear before he had made the five hundred. I was about half an hour making the drawing for the accompanying cut; how many carbon tracings of his first five hundred could Mr. Putnam have made in that time?

"I object to putting pencil drawings out in the shop for several reasons:

"First, it is my experience that they are so hastily made that many of the important dimensions are often omitted, causing the workman, or perhaps the foreman, while he stands around, to run back to the draftsman, or his chief, and interrupt him in some important calculation. Second, mistakes are more com-



NO. GLAND	A	B	C	D	E	F	G	H	I	J	K
60	$4\frac{3}{4}$	$3\frac{1}{2}$	$2\frac{17}{32}$	$1\frac{1}{4}$	2	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$

Machinery, N. Y.

"Labor-saving Scheme for Making Drawings."

mon on pencil tracings than on finished drawings. Third, if a workman makes a mistake on the work he can easily change the figure on a sketch, and sometimes does. Fourth, if the sketches are ever returned to the drafting room, which is doubtful, they are covered with grease and dirt and badly mutilated. Fifth, the sketches are generally of all sizes and shapes, and are very difficult to file away or put anywhere where they can be readily found when wanted.

"While it sometimes becomes necessary to use such sketches, let us avoid it wherever possible. While I believe in doing just as little work as possible and that in the quickest and cheapest way we can, do not let us do it in such a way as to cause us weeks of sleepless nights and to be "blessed" by everyone connected with the concern we are working for some time in the future.

"Templates can very often be used to advantage, but great care must be taken to get the work accurate. One cut out of cardboard or sawed from a ¼-inch board, is not good enough for complicated machines, such as a loom drawn one-fourth size. It should be laid out on zinc under a magnifying glass and filed up by a man who can work right up to a line."

A Mechanical Device for Draftsmen---A Unique Absorbing Pad.

A VERY good article has come on the market, which is in the form of an Absorbing Pad, so constructed as to make tracing or writing in any form neat and clean. The Pad is made of fiber, in two parts, with a central pivot so as to allow it to rotate. This is for placing in or taking out the Absorbing Pad, which takes up the ink, and prevents the heel of the hand or little finger from moistening the tracing cloth or paper, as may be the case. It is neatly gotten up, and sells for 25c. The advertisement is elsewhere in this paper.

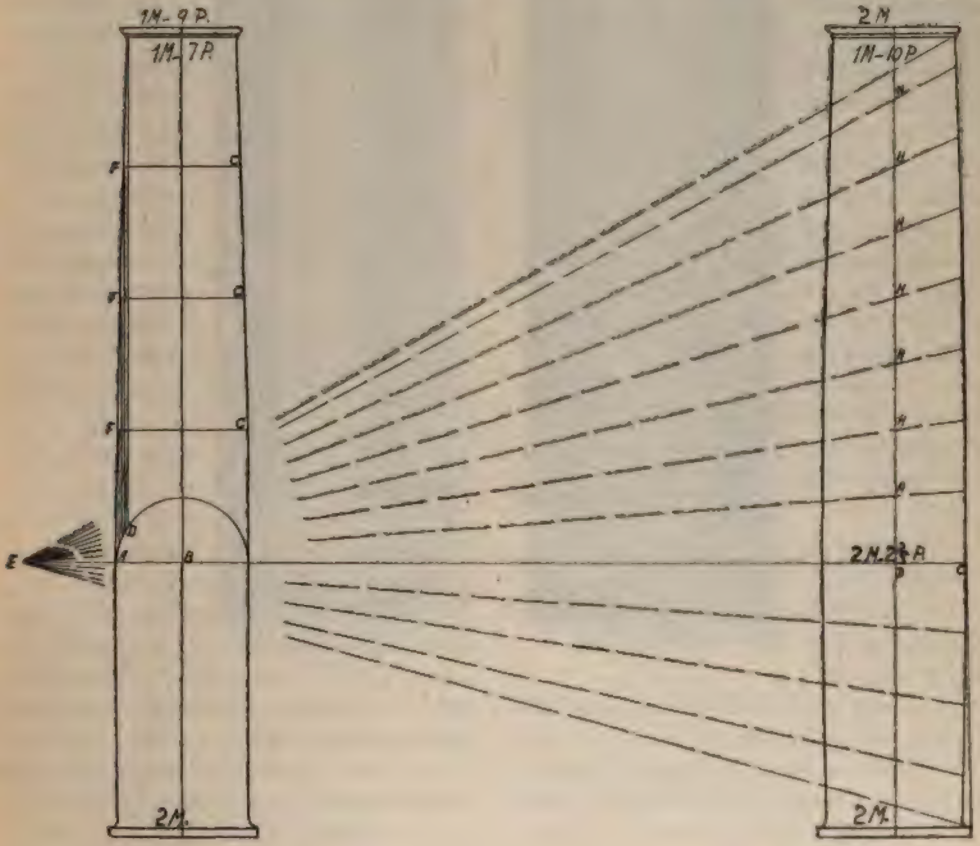
ARCHITECTURAL.

The Order or Style of Columns in Architecture.

IN architecture the word order signifies a composition of a pedestal, a column and an entablalature, together with their ornamentation.

Each of these are divided into three parts, which are for the Pedestal: Base, Plinth and Cap; for the Column: Base, Shaft and Capital; for the Entablature: Architrave, Friese and Cornice.

Since so many of the large buildings are arranged with columns, and these are more generally without a pedestal, we will take up only the column base, shaft and capital, leaving the other details to



another article.

There are five orders of Architecture, of which three are Greek,—the Doric, Ionic and Corinthian, — and two Italian, the Tuscan and Composite.

One often will find combinations of these in the columns of a house or building, and our illustration will show only the base, shaft and capital of the column.

DORIC.

IONIC.

For use in measuring and designing in the orders architects have adopted a convenient measure called a Modulus. This modulus (measure) becomes a unit of measurement, and is generally so selected that it is easily subdivided. That is to say that the modulus is a variable measure chosen as the architect's taste and talent dictate.

Generally, the modulus taken is the radius of the largest part of the column.

This modulus is divided into parts, and each part equally subdivided.

Vignola divided his modulus for the Tuscan and Doric orders into 12 parts and the others into 18 parts.

As a general rule, Vignola divided every order, without pepestal, into 5 parts, 4 parts for the column and 1 part for the entablature.

He gave the Tuscan column, with base and capital, 7 diameters in height from which the entablature is 3½ moduli high. Hence the total height is 17 1-2 moduli or 8¾ diameters.

The distance between centers of columns is 6 moduli and 8 parts or 3 2-3 diameters.

For the Doric order, the measurements were made as follows: The total height was divided into 20 parts, one of which serves as a moduli and which is also divided into 12 parts.

The base with the fillet of the base of the column is one modulus high. The shaft with fillet and head is 14 moduli high. The capital has a height of one modulus. The entablature is 4 moduli high or ¼ of column with base and capital.

The best spacing of columns in the Doric order is 7 1-2 moduli between centers or 3¾ diameters.

It must be remembered that the Ionic, Composite and Corinthian modulus is divided into 18 parts.

In the Ionic, the total height is divided into 5 parts, 4 for the column with base (not the pedestal) and capital and 1 for the entablature.

The column with base and capital is 18 moduli high, the base being 1, the shaft 16 1-3, and the capital 2-3 modulus respectively.

The distance between columns is either 4 1-2 or 6 1-2 moduli.

The column base is 2 moduli and 14 parts square the square part is 6 parts high.

In the Corinthian order the total height is divided into 5 parts, 4 for the column with its base and capital and 1 part for the entablature.

The column with base and capital is 20 moduli high.

The column is divided thus: Base, 1 modulus; shaft, 16 moduli and 12 parts; capital, 2 moduli and 6 parts high.

The distance between centers of columns is 6 moduli and 12 parts, or 3 1-3 diameters. The base is 2 moduli and 14 parts square, and the square portion 6 parts high.

The Composite column is like the Corinthian, with the exception of the base and capital, the latter being made up from the Corinthian and Ionic.

CORINTHIAN.

TUSCAN.

The plan and profile have the same proportions as the Corinthian, but has the involute of the Ionic.

THE ATTIC BASE

The Attic base has been used indiscriminately for all the orders except the Tuscan, because of its beauty, but it is said to be only appropriate for the Ionic.

TAPERING COLUMNS.

The taper of columns may be found by the following method: At a point one-third from the bottom draw a horizontal line across the center line of the column, and with this point of intersection describe a semicircle. From this point the column is tapered upward.

Divide the portion above the semicircle into any number of equal parts. From the top diameter which is 5-6 of the diameter at the bottom, drop a perpen-

dicular upon the semicircle at the point D. Divide arc DC into the same number of equal parts as in the upper part of the column.

From each one of these points, erect perpendiculars to the division lines across. The points of intersection F will be points on the surface of the column which is finished as at G.

SECOND METHOD.

Vignola invented the following, which is considered simpler. A point 1-3 up on the center line of column is selected as before.

Through this point a horizontal line is drawn, making D to E 6 diameters.

Any number of points are found as H, H, etc., and from E draw lines through these points.

Each one is made of the same length as DC from H and the outline of the column defined. The left line will be found in the same way.

This method is best for Ionic, Corinthian and Composite columns.

FLUTING COLUMNS.

Vignola gave the column of the Doric order 20 flutings by dividing the largest diameter of the column into 20 equal parts.

COMPOSITE.

Place a leg of a pair of compasses on one of the points and with a radius equal the chord between to adjacent points on the circumference make an indefinite arc outside the circle of the column.

Reverse the compass and make an arc crossing the first. This point of intersection is the center of the arc forming one fluting.

The flutings of the Doric order meet in a sharp edge.

For the Ionic and all other columns, Vignola divided the circumference into 24 semicircular flutings which are 3 1-2 parts in diameter. That is, the moduli being 18 parts, there would be 36 in the diameter of the column and 3 1-7 of the parts is the width of the fluting.

Draftsmen's Club.

AT the second annual election of the Architectural Draftsmen's Club, of New York, the following officers were elected to serve on the Executive Committee for the year 1905 :

President—L. A. Cramer.

Vice-President — A. T. Rose.

Recording Secretary — W. F. Anderson.

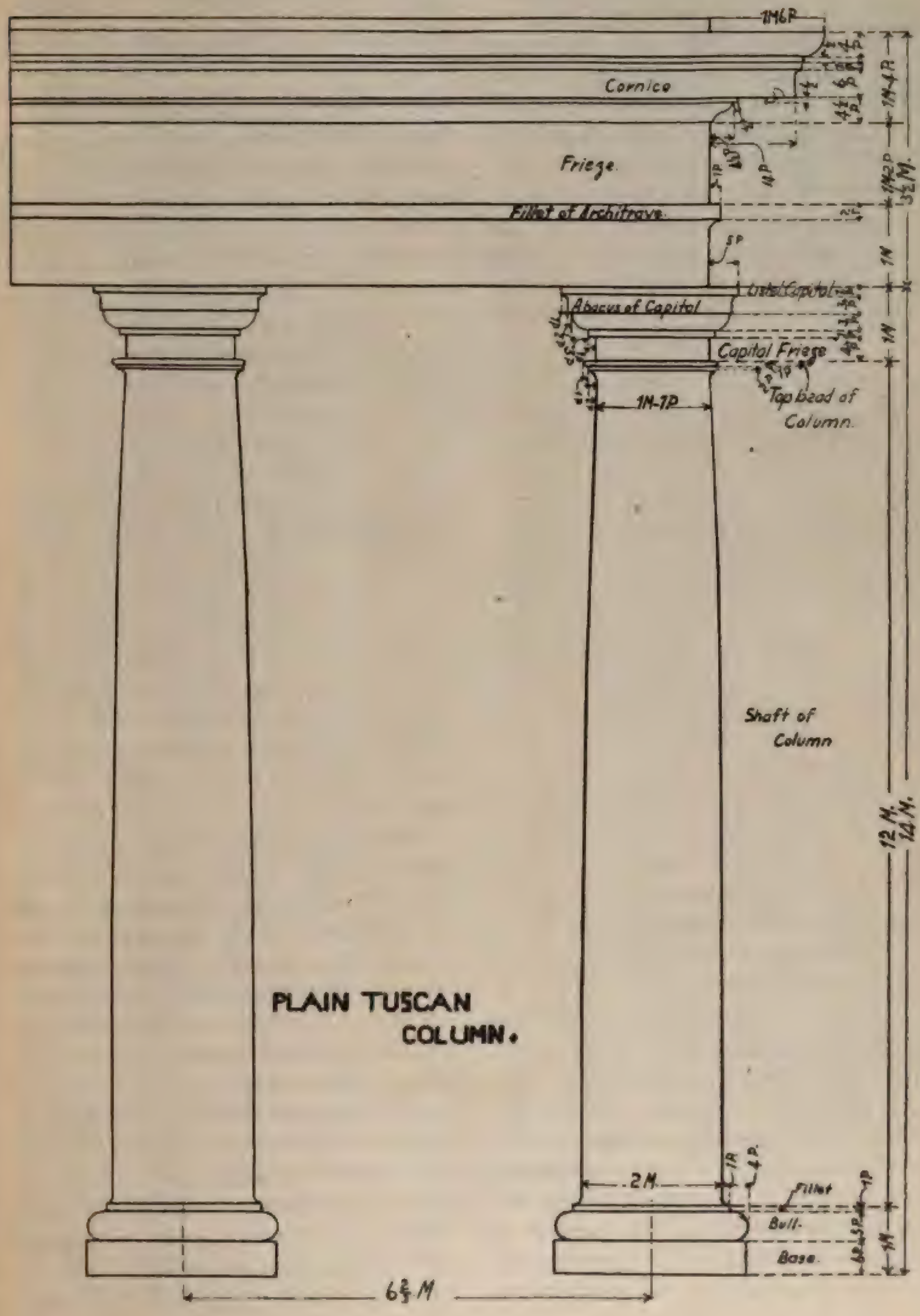
Corresponding Secretary —W. T. Smith.

Treasurer—A. M. Hedley.

Chairman Current Work Committee—E. H. Rosengarten.

Chairman Entertainment Committee—C. F. Winkleman.

A program of varied and interesting monthly prize competitions, combined with a series of discourses by prominent professional men, will constitute the years current work. W. T. SMITH.


Cornice
Frieze.
Fillet of Architrave.
Abacus of Capital
Capital Friese
Top bead of Column.
1M-1P
Shaft of Column
PLAIN TUSCAN COLUMN.
2M
Fillet
Bull.
Base.
12 M.
14 M.

Mounting Blue-prints.

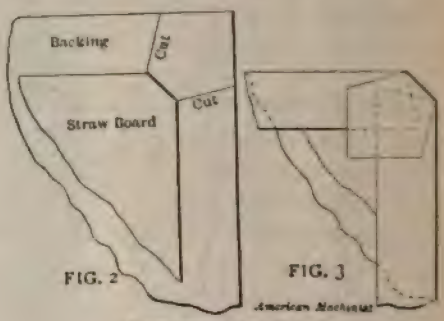
A WRITER in *American Machinist* says:

"Some few days ago I had occasion to visit a shop with which the readers of your journal are familiar, by reputation at least, and which if I were to name, all would immediately associate with all that is modern and up to date.

"In justice it must be admitted that most everything was as expected, which fact, however, only served to bring out in greater contrast the thing which attracted my attention immediately I got inside the door. This was the apparent neglect of the working blueprints. To say I was surprised is putting it mildly, when upon inquiry it was revealed that they had never adopted the system of mounting their blueprints, and thereby keeping them in a presentable state. Some that I saw were in such a dilapidated condition that I really believe the workmen must have had to guess at the dimensions on them.

"Now, where the economy of this comes in I cannot see—if economy is claimed for it. Certainly it is not economy to have the blueprints in such a state that the dimensions cannot be correctly read. Mistakes are costly. A single one may easily cost as much as the mounting of the entire set of shop prints.

FIG. 1. OUTLINE OF PRINT AND BACKING.



MOUNTING PRINTS.

"I believe, though, that the mounted prints are the cheapest, without considering the safety and convenience in their use. The life of an unmounted blueprint in the shop where it is in daily use cannot be much more than three months, and is probably less. In contrast to this, I have blueprints in daily use in departments where they are subject to the worst conditions, that have been in the shop for fifteen and eighteen months, and with an occasional bath are practically as good as the day they were made. These are mounted upon straw-board and cost to mount as follows:

Print, 11¼x17 1-2 inches $0.020

Straw-board, 12x18 inches	.017
Backing, 14x20 inches	.001
Paste	.001
Shellac	.010
Boy's time	.025
Total	$0.074

Now, assuming that the lives of the two kinds of prints are as before stated, as the end of fifteen months we have the unmounted prints costing 10 cents, and the mounted ones 7.4 cents, and the latter still in use.

In Fig. 1 is shown in outline a blue-print mounted on straw-board. The method of mounting is as follows: The backing, which is of common manila wrapping paper and about 2 inches longer than the straw-board, is dampened by drawing rapidly through the water in a blue-print bath. It is then laid upon a sheet of wet glass and smoothed out with a sponge. The paste, which is simply a mixture of flour and water, is then applied with a soft brush. The straw-board is now laid upon the backing; leaving an even margin all around. The board with the backing now adhering to it is turned over and the backing smoothed on the board with the sponge. The two are now reversed again, and, with the backing upon the glass, the corners are cut as shown in Fig. 2. More paste is now applied along the sides and ends of the face of the straw-board, and the overlapping sides and ends of the backing are brought over and pasted down, as shown in Fig. 3.

The unfinished mount is now ready for the print, which, after wetting in the same manner as the backing and giving a coat of paste, is laid on the straw-board and thoroughly rubbed with the wet sponge until all the wrinkles have disappeared.

Wash, and wipe off all the paste, and with sheets of straw-board to absorb the moisture, put in a letter press or otherwise hold tightly so that they cannot warp, and leave until dry. It is not well to press too tightly. All that is necessary is enough pressure to keep the prints straight while drying. After they have become thoroughly dry, give them them two thin coats of white shellac.

This is not the only method of mounting blueprints, but it if a very good one, and when nicely carried out makes a very neat as well as a durable job." J. F. M.

Waterproof Paint for Wood or Stone.

A waterproof paint is very useful about the farm. The following is recommended as being cheap and efficient on both wood and stone:

Melt 12 ounces of resin; mix with it thoroughly 6 gallons of fish oil and 1 pound of malted sulphur; mix some ochre or any other coloring substance with a little linseed oil, enough to give it the right color and thickness; apply several coats of the hot composition with a brush. The first coat should be very thin.

Messers. Spon & Chamberlain, 123 Liberty St., New York City, have just ready an important new book by J. H. Kinealy, M. Am. Soc. M. E., on the design and construction of Centrifugal Fans, fully illustrated from original drawings with many formulas and tables. This is the most comprehensive treatise on this important subject ever published, and will prove of great value to draftsmen and all engineers interested in fan efficiencies. During the many years Messrs. Spon & Chamberlain have been publishing high class technical books, their dealings have been uniformly fair and liberal, and our readers will find it both pleasant and profitable to do business with them.

HOME STUDY.

Mechanics.

CHAPTER V.

Friction.

FRICTION is resistance to motion caused by a peculiar condition of surfaces in contact. Frictional Resistance is the force necesary to draw a body in a horizontal direction, and it is designated by F.

The *Coefficient of Friction* (μ) or the measure of friction is the Frictional Resistance divided by the normal pressure between the surfaces; in the case of a body on a horizontal surface the normal pressure is the same as the weight. In Fig. 1 $\mu = \frac{F}{W}$ if F is the Frictional Resistance and W is the weight of the body.

The Coefficient of Friction between two surfaces can be measured as shown in Fig. 1 by finding the weight at F

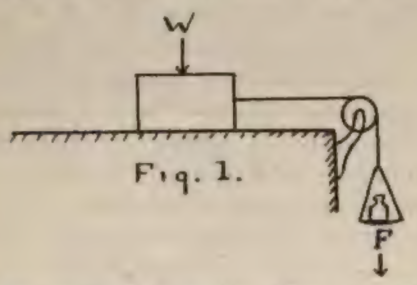


Fig. 1.

which will just keep the block moving. An easier method is as follows: Incline the surface as shown in Fig. 2 until the block slides easily after starting; then the Coefficient of Friction is the ratio of the height H to the length L. This is shown as follows: Draw W to represent the weight of the block to scale; resolve this into two components, N normal to the surface, and F parallel; then evi-

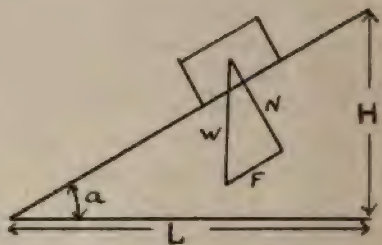


Fig. 2.

dently F is the Frictional Resistance and N is the normal pressure, and $\mu = \frac{F}{N}$ but from similar triangles $\frac{F}{N} = \frac{H}{L}$, therefore $\mu = \frac{H}{L}$.

The angle a is called the friction angle. Evidently $a = \tan^{-1}\mu$.

The principle laws of friction are:

1. Friction is directly proportional to the normal pressure.
2. Friction is independent of the area of the surface in contact, provided the normal pressure is constant.
3. Friction is greatest at the beginning of motion.
4. Friction is greater between surfaces of the same material than between surfaces of different materials.

5. Friction depends upon the condition of the surfaces in contact.

We will now take up some special cases of friction. Suppose we are drawing a body up an inclined plane which makes an angle (*b*) with the horizontal. (Fig. 3.) Draw W to represent to scale the weight of the body; draw *c d* ⊥ to the plane, and draw *c e* making the ∠ *d c e*

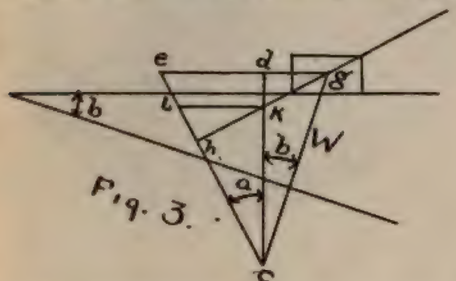


Fig. 3.

equal to the friction ∠; then draw *g h* parallel to the direction of pull, and *g h* represents to the same scale as W the force necessary to pull the body up the plane. This can be shown by drawing LK parallel to the plane, and is left as an exercise for the student. The least possible pull is evidently obtained when *g h* is perpendicular to *c e*; in other words, the direction of pull should make

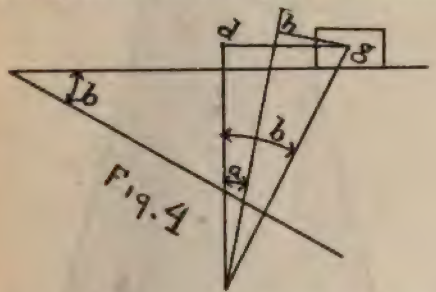


Fig. 4.

an angle equal to the friction angle with the plane.

If ∠ *b* is 0, that is, if the plane is horizontal, it is evident that the easiest way of drawing the block is to make the ∠ of pull equal to the friction ∠.

If the body is being lowered along an inclined plane, the ∠ *a* will be set off to the right of *d c*, because friction now subtracts from the lowering force.

The minimum pull for such a case is shown in Figs. 4 and 5. In Fig. 4 the friction angle *a* is less than the angle *b* of the plane, and a force *g h* must be applied to prevent the body sliding down the plane. In Fig. 5 *a* is greater than *b*, and the force *g h* must be applied to draw the body down.

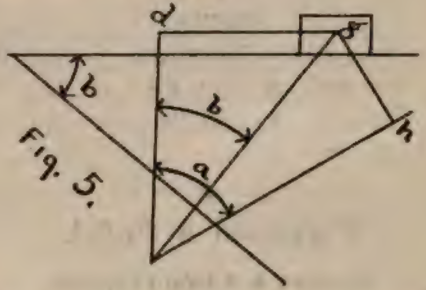


Fig. 5.

Rolling Friction is caused principally by a condition of surfaces as shown (magnified) in Fig. 6 or Fig. 7. They are self-explanatory.

EXAMPLES.

An automobile will just roll down a 30° hill. What will be the force in lbs. necessary to just draw it up a 45° hill? A 20° hill?

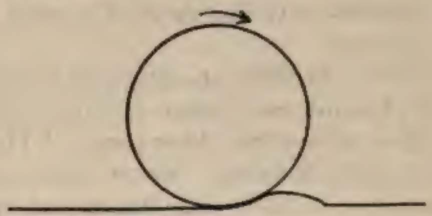


Fig. 6.

What will be the force necessary to just allow it to run backward in both cases?

What will be the force necessary to draw it along a horizontal surface?

In all five cases consider the weight as 1,000 lbs., and the force as being applied parallel to the running surface.

In all five cases of the above example find the least force necessary to move the automobile.

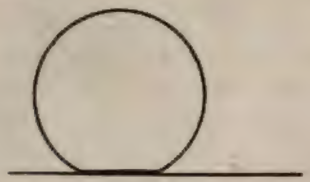


Fig. 7.

ANSWERS.

1—1115 lbs.	2—885 lbs.	3—298 lbs.
4—200 lbs.	5—577 lbs.	6—966 lbs.
7—766 lbs.	8—259 lbs.	9—174 lbs.
10—500 lbs.		

Views of a Point.

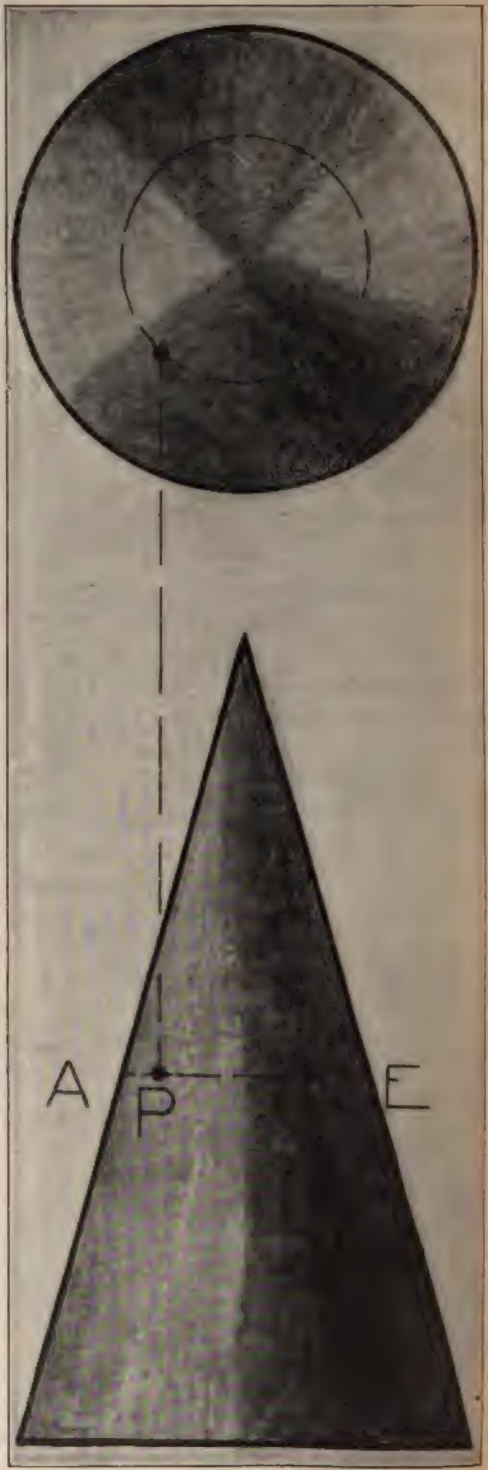
By Prof. A. Edward Rhodes.

MANY students experience considerable trouble in understanding the principle involved in finding the position and shape of a given part of an object by projecting from a given view of the object to the view it is desired to find. I find that the following rule is a good help to my students.

Problem.—To find views of a point on a compass.

Rule.—Surfaces are imagined as made up of an infinite number of lines which may be either straight or curved. These are called Elements. Every point on a surface is in some one element of that surface.

Illustration.—Let Fig. 1 represent the top and front views of a cone. P is a point on the surface of the cone, and in any desired position in the front view. Any line, as A—E, passing through the point P is an element on which P must lie. Having the two views of the element A—E, the position of P in the top view is on the top view of the element A—E, and directly above P in the front view.



ILLUSTRATING.

Caricature.

From the "Acme Course."

A CARICATURIST is a wit who knows how to express himself through the medium of pictures. He is an exaggerator, a distorter, and a deformer, but there is a method and a purpose, good and bad, in his manner of procedure. A bad drawing is not a caricature, and a caricature is not a bad drawing, though some of them cannot be called good drawings, depending oftentimes on who makes them.

If you wish to make a caricature of some person, the first thing for you to do is to familiarize yourself with the normal outlines and physiognomy of the individual in question. Be sure that you note well all of the leading characteristics of form, face and expression. Next find out what you can about his personal habits, general business, and manner of doing things; his religion and politics. Some of this information you may not use, and it is not always possible to get it; but the more you get, the better equipped you are to do your subject justice, or injustice, as the case may be.

If sketches from life are possible, very good; if not, a picture will have to answer. Get two or three different poses if you can. The same is also true of sketches.

Having everything together, start in by taking an invoice of stock on hand. Carefully analyze your "subject" to determine the weakest and the strongest points in the general make-up of the character. The ones chosen as points of attack will depend on the kind of a caricature you are going to make, for there are two kinds with their variations. One is merely to make fun and friendly comment; while the other is as a two-edged sword, or an upper cut in the solar plexus.

Suppose the subject to be a "pothouse politician" of the usual type, posing as a friend of the poor and a follower of the faith, while in reality we have learned from our invoice that he is quite the reverse of any of these things, — an oppressor of the poor, using his religion as a cloak to hide his meanness. Suppose you wish to go after him and to crucify him on your pen point and hold him up to the scrutiny of a much-abused public. Rather a mean thing to do, but frequently the end justifies the means and the meanness as well.

The first thing to decide upon is some attitude or striking position, portraying the subject in some dastardly act that typifies the characteristics which it is desired to be brought out. Next decide the best way to get the most out of your material; that is, whether to make him with a big head and small body, or vice versa, or natural proportions and distorted perspective, etc. These are a few

of the usual ways of producing caricature effects. Now roughly block in the general position of the figure, in the position that we choose to represent. Perhaps we have decided to make him in a fawning attitude, "crooking the pregnant hinges of the knees" before the humble citizen with a vote; one arm extending the "glad hand" to the aforesaid voter, with perhaps a cigar between the fingers, the other with "itching palm" open behind the back to receive a bag of boodle, etc., etc.

Having roughly blocked in the figure and assured yourself that the general proportions are as you wish them to be, next get the expression and the likeness, then the distortion of the features or the caricature effect. Perhaps we want a "heavenly fawn" on one side, and a "devilish wink" on the other; not an easy thing to draw, either of them, and the combination is still worse, but one must be ready for almost anything when it comes to caricatures. The expression is produced by following certain definite rules (too numerous to mention in this brief article), but a few suggestions are here given. If portraying joy or pleasure, the corners of the mouth are elevated like a new moon that will "hold water"; the reverse produces the "down-in-the mouth" effect, sorrow, etc. Anger is produced by a firm mouth and knit eyebrows closing down over the eyes. Fright is portrayed by up and down features; not only the hair should stand on end, but also the eyes, mouth, nose and ears, and the face itself should be elongated. A funny expression is produced largely by placing the eyeballs in some unusual side position. Whatever expression you seek to produce you must not forget the other points, a likeness and a distortion, otherwise you will not have a caricature but a bad drawing. Possibly it may be a good drawing but a bad caricature, because it does not identify the subject caricaturized; that is, the likeness has lost out. In making a good caricature of any face or form, each feature must be carefully analyzed, and the strongest one or ones magnified or minimized. That is, if the victim has a small nose, keeping the general shape of the real nose, diminish the size of his "smeller", until it looks like a wart. On the other hand, if the nose is large increase its natural size two or three times, but remember that a large nose indicates a strong character in some way, and if you wish to represent your subject as a weak character, leave the nose normal and tackle something else. Or if you find it necessary to use the large nose, then weaken the chin, and you will still have a weak character, You can see by the above that you might make a good caricature, as far as the drawing was concerned, and still fail to represent the idea.

It is sometimes only necessary to distort a single feature to produce an excellent caricatured, and you can readily see that when this is the case it is much easier to make a likeness.

When things are Hard.

When things are hard, it is best to dart
And tackle the handiest way,
To get a good start, with a resolute heart
And genius that's cheerful and gay.
And should you get beat, do not retreat.
But tackle and tackle until you
succeed.

C. C. Riester.

We have printed a complete index for Vol. 3, 1904. Those wishing one, can get it by addressing The Draftsman.

CURRENT TOPICS.

RUN if you like, but try to keep your
breath;
Work like a man, but don't be worked
to death.

—*Holmes.*

MANY good offers given with a year's subscription to THE DRAFTSMAN.

TALENT develops itself in solitude; character is the stream of life.

A GOOD time to make good resolves is in the beginning of the year. Resolve to get THE DRAFTSMAN each month.

THE perfect man has not been discovered in our day; we are all too modest to reveal him.

THERE are many new things advertised each month. Look over the ad. pages.

FAILURE is only endeavor temporarily off the track. How foolish it would be to abandon it in the ditch.

KEEP posted on the "Wants" and "For Sale" columns by going over them every month.

Do not think that when a man is looking over a print or drawing that he is killing time. He may be.

SOME of the characteristics of good printing which was shown in THE DRAFTSMAN a few months ago, appear now. We hope to do it regularly.

A NEW invention for insuring dry seats on electric cars in wet weather has been displayed in Edinburgh. It is practically a wooden covering for the seat, can be lifted in wet weather, the ordinary movement of the back rest of the seat locking it in position. It would be quite a blessing in this country when open cars are used.

A SCHOOL teacher boxed the ears of a pupil a few days ago. The boy told his mother, and the next day the teacher received the following note: "Nature has provided a proper place for the punishment of a boy, and it is not his ear. I will thank you to use it hereafter."

Many of us travel by freight in this world because we can't express ourselves.

Every time some women get a little money ahead they have an attack of nervous prosperity.

A Record of Valuation of Drawings.

MR. C. E. WOODS, in his article on Factory Production Cost, in *System*, suggests the card index system, with cards of the form as shown, for keeping the complete record of the valuation of drawings, tracings and other data.

The form is self-explanatory, except perhaps it might be well to add that the back of the card is used for carrying an inventory of valuations of these drawings from year to year.

CARD NO.				DRAWING & TRACING CARD					
				DRAWING NO.			NEGATIVE NO.		
TITLE									
				PENCIL SKETCH					
DATE	MADE BY	TIME	RATE	COST			DISPOSITION		
		HOURS	PER HOUR	FIRST	ALTERATIONS	FINAL	FILE NO.	OTHERWISE	
				TRACING					
				INK SKETCH					

Telephone Course at Purdue University.

THE third years' course at Purdue University, Lafayette, Ind., which has just commenced, shows a large increase in enrollment over that of last year.

This department is considered as one of the valuable adjuncts to the study of electrical engineering, and is consequently carried out in a most thorough manner. The laboratory contains almost every type of switchboard and telephone apparatus, which are dissected and studied from beginning to end. The students use a fully equipped exchange having an ultimate capacity of 1,000 lines.

In the Future.

IN the future THE DRAFTSMAN will be changed only as far as width of column is concerned, the length remaining about the same. The type will be the same but greater care will be exercised in the proofreading and the arrangement of mathematical work. Illustrations are to be as large as needed and as clear as possible. It has been suggested that the name be changed, but it has been decided to work up the quality of the matter, and if it does not appeal to the draftsmen, then we will sell out.

Separate wrappers are to be used so as to avoid soiled magazines.

An Ellipsograph.

THE illustration gives a clear idea of the invention of Mr. Edwin S. Johnson, Lincoln, Neb., which is to aid in drawing ellipses and circles of various sizes.

In Fig. 1, which is a perspective view of the object, 10 represents the body, having pointed feet at each end to avoid slippage. The body has a long central slot in which are two slides, 13 and 14, arranged to be clamped in any position by screws 15 and 17. Upon each slide is a projection, 18 and 19, to which a cord, string or wire is fastened, and 21 is the pencil, which is moved around. Keep the cord tight at all times.

It will be seen that an instrument constructed as shown will when the slides are placed at certain points aid in guiding the pencil point in the path of an ellipse, the ends of the cord being the foci of the ellipse.

By placing the slides together a circle may be drawn, and the flexible connection 20 is designed to be adjusted in length at the projection 19 through the instrumentality of the spring, 22, and the bar, 23.

Mr. Johnson's patent is No. 768,997.

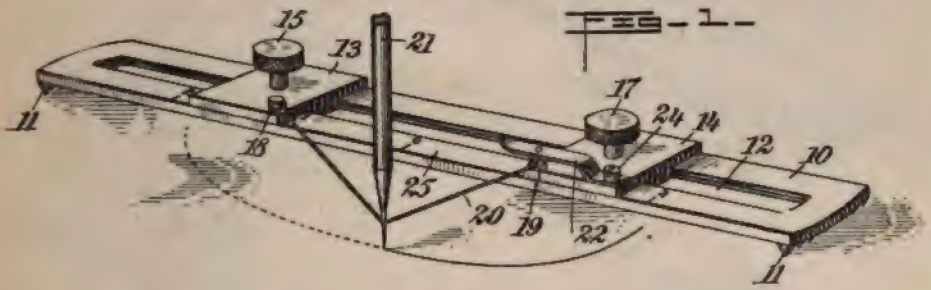


FIG-1-

Instruments for Drawing Curves

THE object of this invention by Mr. Ernest J. Loring, of Somerville, Mass., is to provide an instrument adapted for a drafting instrument to generate or test tangential curves, or adapted for use as a testing or working templet for any constructional or mechanical work requiring the generation or transference of relatively flat curves.

To this end it embodies a ruling edge of adjustable curvature, so regulated in dimensions and material between its fixed point and free end as to invariably assume the same curvature for any given position of either extremity.

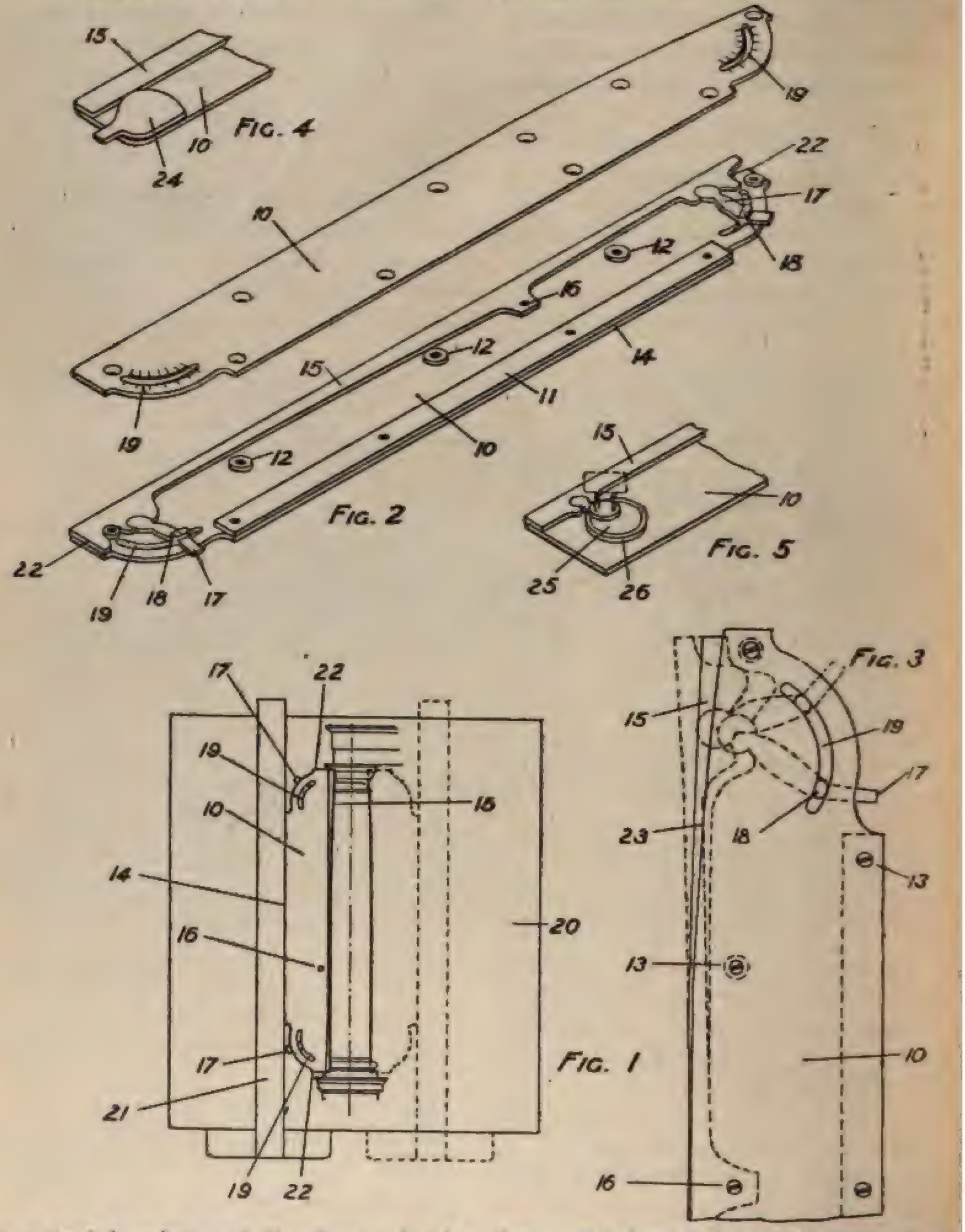
The rate of curvature of the particular curve for which the instrument may be arranged can be expressed as a continuous or progressive function of the length of the arc, and the instrument will generate such a curve with the closest accuracy.

It may be used to transfer any curve from work to a drawing if the curve is of the same characteristic of curvature as that for which the particular instrument is fitted

The Fig. 1 is a plan view of a drafting board and T-square with the instrument in place. Fig. 2 represents a perspective view of the instrument showing top plate separated from the rest of the instrument, while Fig. 3 is an enlarged plan view of one end. Figs. 4 and 5 represent detailed perspective views illustrating two modi-

fied forms of mechanism for adjusting the ruling guide (15).

The back edge (14) of the instrument



is a straight edge, and the front edge is a ruling edge (15) of adjustable curvature, fixed in its intermediate portion at 16 at a point about one-third of the distance from one end, and having free end portions or extremities, one of which is thus made about twice the length of the other.

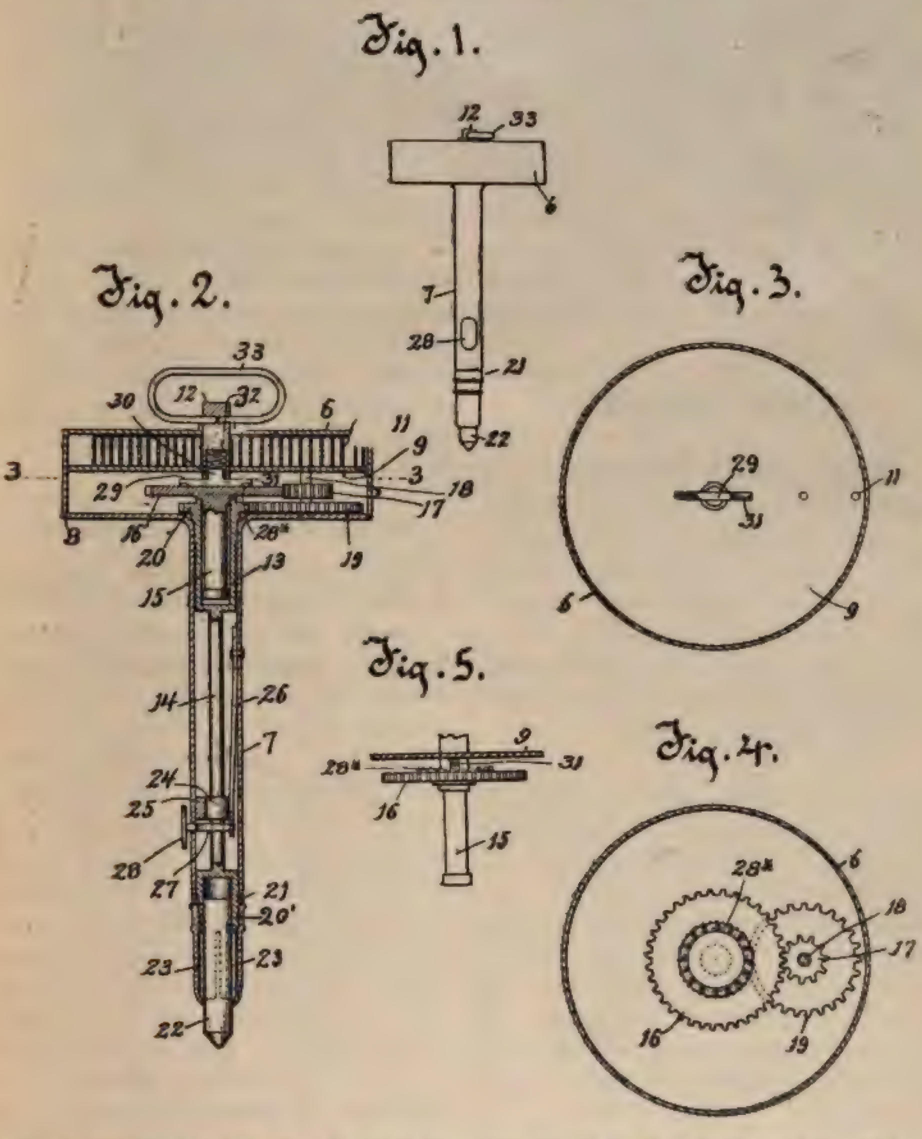
These extremities are engaged by

pivoted levers (17) in the form of the invention shown in Figs. 1, 2 and 3, having projections (18) occupying curved cam slots (19) in the frame plates, the pivots of the levers being eccentric, which shifts the extremities of the ruling edge (15) one way or the other. The edges may be graduated so that different predetermined adjustments may be effected.

A Mechanical Eraser.

EVERY draftsman realizes the energy expended in erasing pencil and ink lines, and also that there must be considerable pressure to accomplish good results. A mechanical eraser that will do the work neatly and quickly would be quite an aid in a large number of places.

Mr. Robert T. Merrill, of Milwaukee,



Wis., has patented an instrument, here illustrated of which Fig. 1 is a front view, Fig. 2 a side sectional elevation, and Figs. 3, 4 and 5 other views.

The device consists of a housing for the mechanism and a shaft, at the end of which is an eraser, there being a coil spring like in a clock attached to a train of gears which give motion to the shaft.

By means of a friction block (25) and a flat spring (26) secured to the interior of the casing of the shaft, and key or button (28), the speed of the shaft is controlled. Key (33) projects from the top of the head to aid in winding up the spring, which shonld be strong enough for several rubs before it need be wound again.

BOOK NOTES.
—and—
Engineering Reviews.

ARCHITECTS' AND ENGINEERS' HANDBOOK of REINFORCED CONCRETE CONSTRUCTIONS. A series of fine articles on this subject now appearing in *Cement and Engineering News*, Chicago. The author, Mr. L. J. Mensch, has the articles profusely illustrated with photographs and drawings.

TEXT-BOOK OF GENERAL PHYSICS, by Joseph S. Ames, Ph. D., 760-5x8 pages bound in cloth. The American Book Co., publishers, Cincinnati, O.

This textbook is divided into the following sections: Mechanics and Properties of Matter, Heat, Vibrations and Waves, Sound, Light, Magnetism and Electricity, but preceding all this is a very lengthy introduction on Physical Phenomena.

In mechanics special emphasis is placed upon the fundamental ideas of time, space and force.

Correct definitions of temperature and heat quantities are given under Heat, and the energy relations are discussed in full.

Various types of vibrations and waves are next described and analyzed, and under the subject of Sound much original matter is given.

Under the head of Light, a prominent feature of its treatment is the stress placed upon the idea of resolving power.

The subjects of Magnetism and Electricity are described so that no statements are made that are contrary to the accepted or probable theories as to the nature of electrical charges.

The author claims that no experiment or observation which has an important bearing on our knowledge or theories of physics, that is not mentioned and explained. Reference books are mentioned at various places in the text to enable the student to look up the matter in hand more thoroughly.

Pipe, Fittings and Valves.

THERE has been a good sale of our book on Dimensions of Pipe, Fittings and Valves. Some draftsmen on being approached simply glanced at it and said, "Oh, I have all that stuff in catalogs."

Now, we have been through nearly every catalog printed, but there is not much in them except the illustrations and prices, for manufacturers do not give away full dimensions of their articles. Then, too, a draftsman should be prepared for an emergency. He may be on structural work now, but no telling what he will be working on to-morrow. As one draftsman said, "I am not on pipe work now, but I don't know what will be the next job, and I have been looking for just such matter." We are not discouraged because a few don't want it; there is a large number that do, and they keep us busy filling orders.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Right or Left Hand?

By. E. J. LEES.

THIS is a question that draftsmen are called upon to determine quite often, and sometimes this is no small matter.

Let us consider what right-handed means. Webster's dictionary gives the following: "Having the same direction or course as the movement of the hands of a watch seen in front." While this gives us a method of determining the direction, it is rather misleading, according to the mechanical usage of the expression. This will be seen when compared with mechanical tools; a twist drill, for instance, is said to revolve right hand. Note that in this case the revolution is determined by the operator being behind the drill, or the screw is driven by the operator from behind, and is said to rotate right hand.

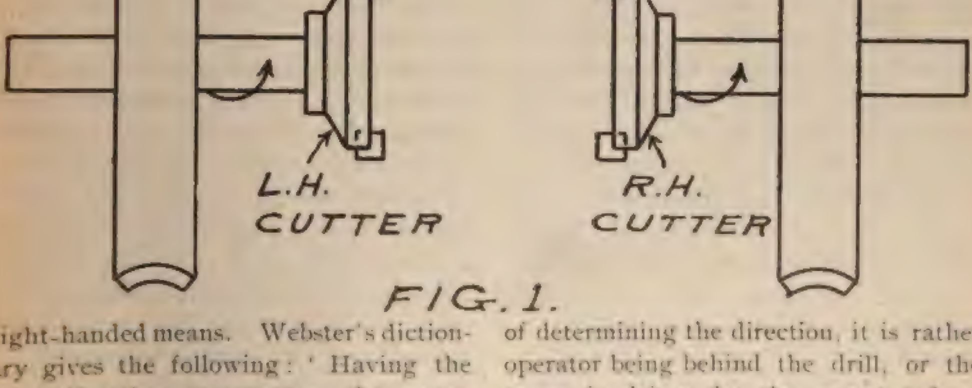


FIG. 1.

Taking these as a standard, the hands

of a watch or clock then run left hand as driven behind.

While this method of determining right or left hand revolution is from behind the object, there arises another trouble in naming parts of machines, etc., and the tendency seems to be to name from the front looking at the machine. Of a planer or other large machine, the right hand housing is not the machine's right hand side, but the housing coming to the operator's right hand when looking at its face or its left hand side.

To determine a method for correctly designating housings for a double end machine with a pair of them at each end is somewhat of a problem.

That we should determine the hand in the case of revolution from behind the object driven is shown in Fig. 1. Here are two spindles, each driven by a worm and wheel, the worms running in the same direction; each spindle carries a facing cutter. The cutting edge of one is left hand and the other right hand, yet they both revolve in the same direction, as can be shown by referring to arrows on the spindles.

This question is often brought home to the draftsman by the patternmaker or machinist, who, using the wrong projection perhaps, makes a lever or other irregular piece the wrong hand after it has been very clearly laid out.

There is one way of preventing these mistakes in reading rather irregular pieces, and that is to letter the corresponding edges, and make three projections.

The Design of a Stuffing-Box.

A STUFFING Box is a part of a machine to prevent leakage, and is used in a large number of places in both light and heavy service. The stuffing box should be used only for making a tight joint, but it sometimes is so placed that it acts as a bearing also. The diameter and length will depend on the pressure of the steam or liquid and on the wear to which it is subjected.

In the case of a horizontal engine, the piston rod works through a stuffing-box, and is supported by it to a certain extent, and the wear that has shown on soft packings has caused the invention of substances that are more metallic in nature.

These metallic packings are considered expensive at first, but the service that they render delude us of that fallacy because they stay tight longer, and are to a certain degree self-lubricating.

The amount of packing has been determined partly by experiment and partly by trial, and is now assumed to be certain thickness for certain diameter of rods.

These proportions have been tabulated by designers, and appear in nearly every book on machine design.

Two things must be borne in mind in the design of a stuffing box to allow sufficient packing and to make the box simple. The most simple design is the one shown in Fig. 1, where the sliding part called the *gland* is forced against the packing by a pair of nuts working on bolts or studs, the latter being secured into the body of the box, and in the former case the boltheads being fitted into recesses.

In Fig. 2 we have a gland and box with composition lining, used in some cases to prevent excessive wear and cor-

rosion, but not necessary in small engines and pumps where the work is light. Since the composition will expand more than the iron of the box and gland these liners seldom get loose, so that pinning will not be necessary.

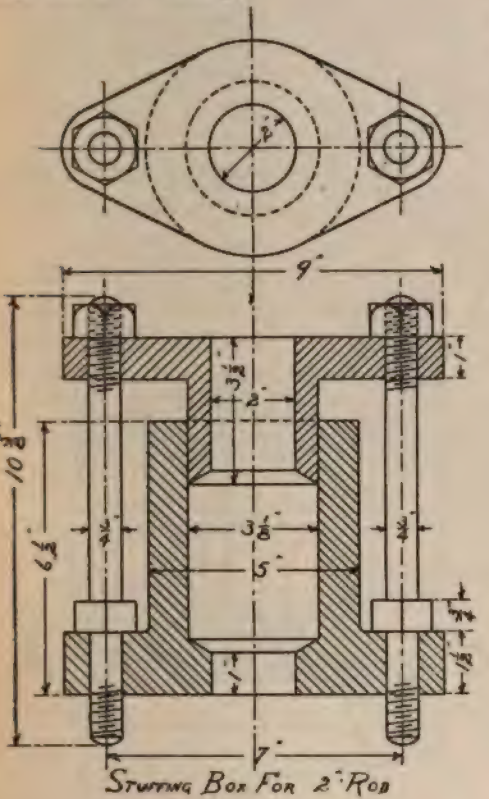


Fig. 1.

In Fig. 2 the box is cast solid with the head of the cylinder, and is the most economical, but sometimes causes trouble in the finishing. When cylinder, one head and stuffing-box constitute one piece, the opening through the latter is generally so small that the boring bar will have to be of a special size, and that fact has led to the design shown in Fig. 3.

Here the opening for the boring bar is ample and finishing the cylinder is more rapid due to the fact that the bar is stiffer and able to do more work.

In Fig. 3, the outer surface of the cylinder head will need to be faced to give a proper bearing for the box, and as in Fig. 1, the hold-down bolts may be the same as the studs for forcing the gland.

Two studs in the gland will answer for small sizes, and is the most common practice, while three are used on larger sizes. The hold-down bolts of Fig. 3 should be designed to stand a pressure on the area around the rod. These hold-down bolts could be cap screws instead of studs as shown, and are usually not less than ½" in diameter.

The area of the threaded portion at the root of the thread multiplied by the safe tensile strength of the metal, multiplied by the number of bolts, will be equal to

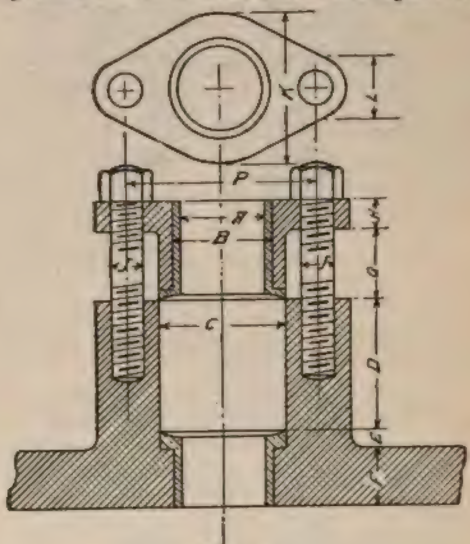


Fig. 2.

the pressure per square inch in the cylinder multiplied by the area around the rod.

Let this be A and pressure of steam p, and the area of the bolt or screw at the root of the thread be a and the safe tensile stress as 5,000 lbs.

Then $A \times p = a \times 5{,}000 \times$ number of bolts.

$a = d^2 .7854$ where d = dia. of bolt at root.

Therefore $A \times p = d^2 \times .7854 \times 5000 \times n$.

Or $d^2 = \dfrac{A \times p}{.7854 \times 5{,}000 \times n}$

Here p is the highest boiler pressure that will ever come on the area around

the rod, perhaps 200 lbs. will be a safe figure.

Either the number *n* or *d* may be assumed and the other one found by the above.

Except in extremely large engines *d* would not need be more than ¾", generally ⅝", and thus put them closer together.

It may be well to reinforce the head of the cylinder or face of the engine bed, and drive the stuffing-box in tight, as shown in Fig. 4.

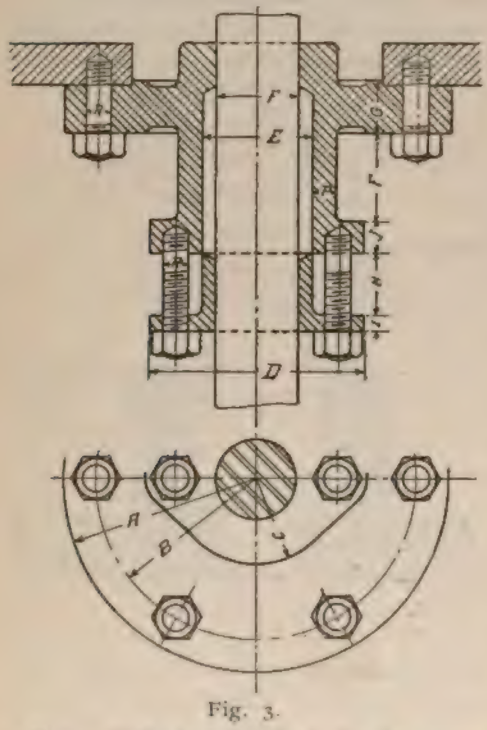


Fig. 3.

The projection F need not be more than ¼", and the amount E only enough to guide the box straight, say one to two inches. This style is cheap and effective, and used by a large number of engine builders.

The body D is sometimes threaded, and a large cap with internal threads arranged to screw over the gland, which is turned circular the size of the body (shown 5" in Fig. 1).

This cap will give a much more even pressure on the packing than with the studs, but is often hard to turn.

The threads on the body and in the cap are usually made the same per inch as would be required on a bolt of the diameter of the piston rod. The cap has notches or holes in its outer surface into which the tip of a spanner wrench is inserted to aid in turning. These notches should not be less than ¼" wide.

In this design the gland is often made of brass, while the box and cap are of cast iron.

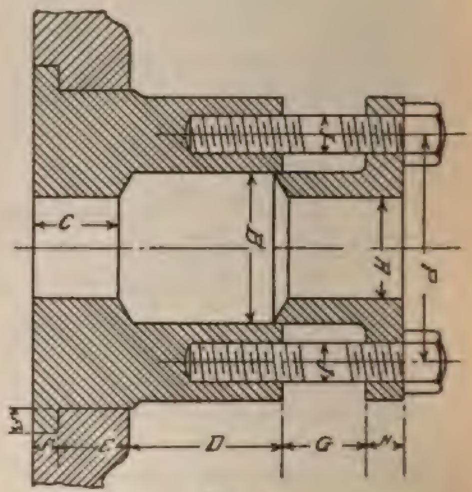


Fig. 4.

The space for packing in all cases should be in $\frac{1}{16}$ of an inch; that is, packing is made in ⅛, $\frac{3}{16}$, ¼, $\frac{5}{16}$, ⅜, $\frac{7}{16}$, etc., sizes, and can be obtained for light and heavy pressures of gases and liquids, the composition varying for the different uses.

Special packings are being sold, but the merits of these should be known by trial rather than by the word of the salesman.

A lot of ilustrations were given in the December issue of this magazine, and a few more are here produced showing various forms of packings for heavy pressure. These are suggestions by Mr. John S. Myers, Philadelphia, Pa.

Make 'em Longer.

THE square shank twist drill is one of the most useful tools made, but the larger sizes have a fault that the makers could easily correct. The drills under consideration are those made to be used in the carpenter's brace. I find that the sizes from $\frac{13}{32}$ down to $\frac{1}{16}$" work splendidly, but the $\frac{1}{2}$", $\frac{17}{32}$", $\frac{5}{8}$", etc., can be used in very few carpenters' braces.

The bits or drills as we find them on the market are made as in Fig. 1. The square part *a*, and the smaller part *b*, are both shorter than they should be. The chuck will come against the body of the drill *c* before the square part bottoms in the socket at bottom of most brass chucks and further if one should happen to have a chuck that will spread enough to receive the body of the drill the jaws are then so wide apart that they will drive the drill by the square part. Now if the shank was made longer even at the expense of the body of the drill, as in Fig. 2, any carpenter's bit brace will drive it perfectly. If the designers and makers of

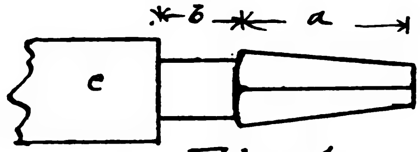


Fig. 1.

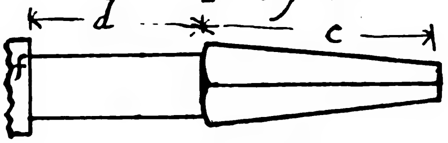
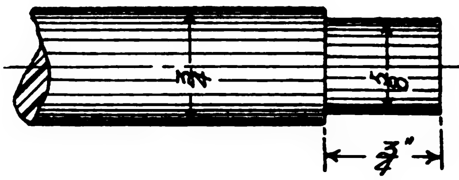


Fig. 2.

tools would note these facts and correct the fault, their drills would be greatly improved, and I am sure the change would be greatly appreciated by workmen generally. R. W. J. STEWART.

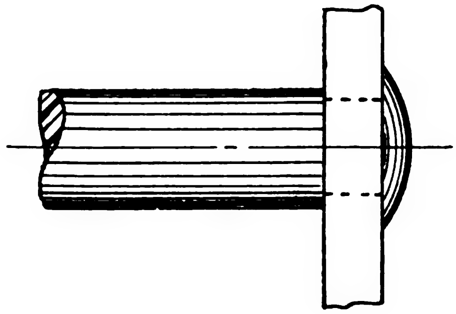
Details of Stack Ladder.

SOME sketches have been received from Mr. Rex C. Wilson on the sizes necessary and the arrangement of the ladder on a smoke-stack.



In Fig. 3 is shown the general arrangement and sizes of parts, also the manner of fastening to the stack.

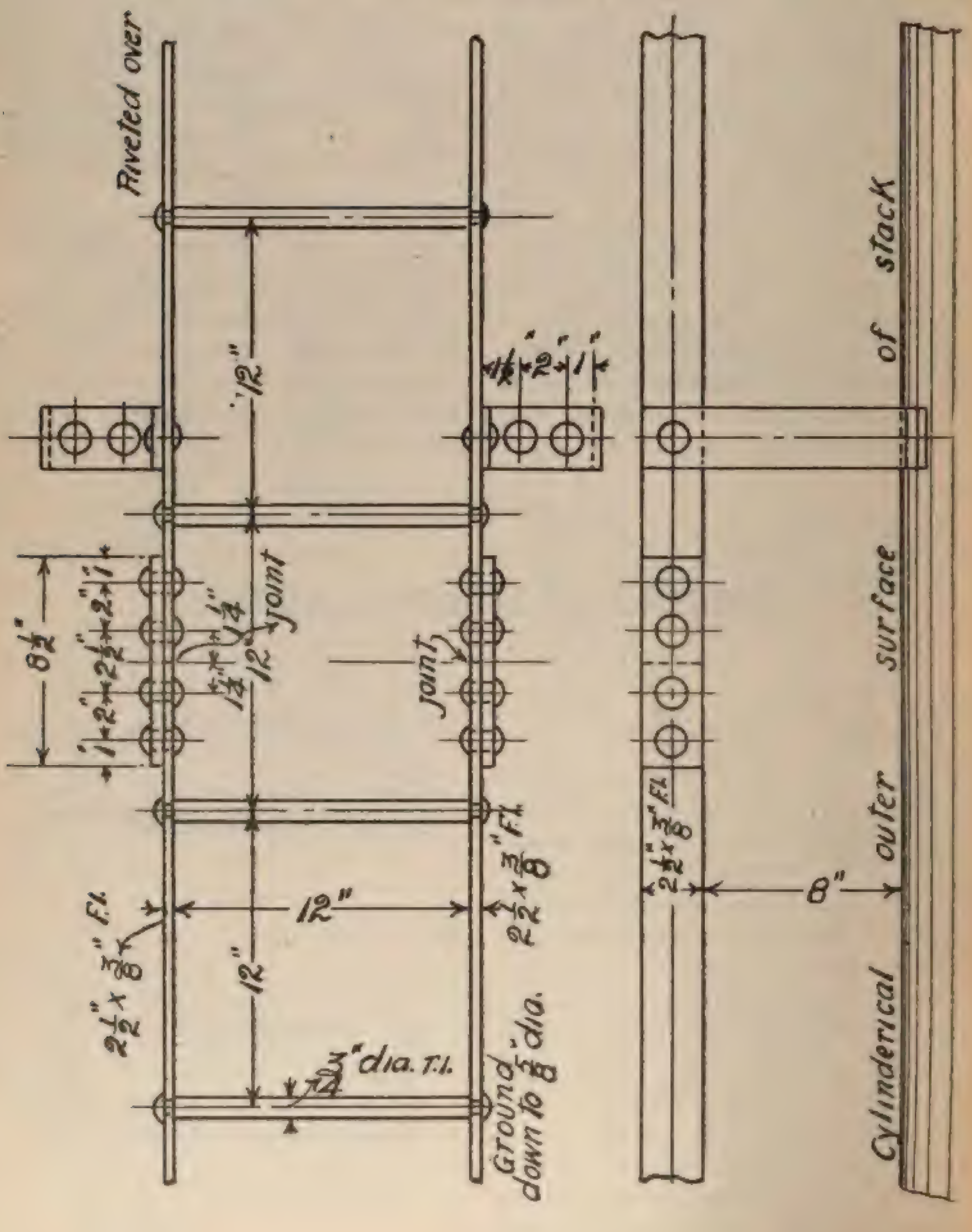
The upper and lower ends of the ladder are made as shown in Fig. 1, though the bottom may be run straight down and fastened to the foundation.



As will be noticed the rungs are ¾" diameter, and may be turned or ground down with an emery wheel, leaving enough in length to rivet over outside

Ladder made in 10'-0" lengths or as near that as possible

Supports, same distance apart as length of section.



the flat iron of the ladder.

The sides are $\frac{3}{8}$"x$2\frac{1}{2}$" flat iron, and the rungs, Fig. 2, are $\frac{3}{4}$" turned down to $\frac{5}{8}$".

The supports and joint iron to be same size as the side pieces.

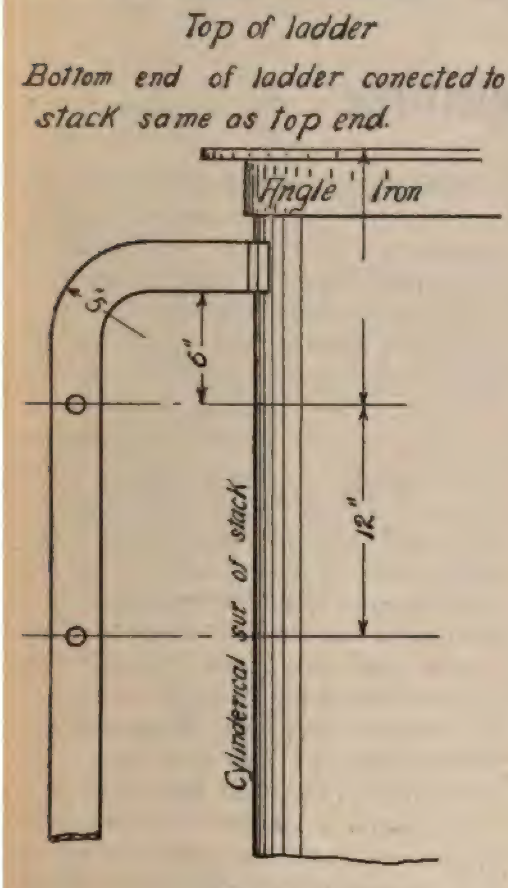


Fig. 4.

The rivets to fasten to the stack should be at least $\frac{5}{8}$", and it might be well to put a strip inside the stack to strengthen the material where the supports are located.

Aluminum as an Abrasive.

Aluminum, despite its metallic character, can be used as an abrasive for sharpening knives. It has the structure of a delicately grained stone, and under friction gives an extremely fine mass which adheres powerfully to steel. Consequently, blades sharpened on aluminum rapidly take a thin, sharp edge which cannot be produced by the best stones. If knives are passed with utmost care over a razor stone, the edge, when magnified 1,000 times, shows irregularity and roughness, while, according to the Zeitschrift fuer Elektrotecknik, edges produced on aluminum, when submitted to the same examination, appear perfectly straight and smooth. We understand that aluminum wheels or hones are being introduced in Europe by M. Bernard.

Heavy haulage work, such as that of stores, munitions and even heavy guns, is already done by motor in the Austrian army. Now the Austrians are going to have armored motor cars, each carrying a quick-firing gun.

The Argentine Republic will spend in the next five years $40,000,000 on new railways and branch lines. Up to the present most of the rolling stock in use on the Argentine railroads has been imported from England, Germany and Belgium.

STRUCTURAL.

Shop Painting

SPECIFICATIONS for painting structural steel work in the shop rarely contain definite directions for putting the paint on. This part is generally covered by the phrase "to the satisfaction of the engineer," or "as the engineer may direct"; clauses which are apt to be much overworked in nearly every kind of specifications. In any event their effect is to shift the responsibility to the shop inspector, who must too often take his cue from the general practice of the shop rather than from the best engineering experience.

The work of painting is generally done in a slovenly manner at best, especially if the surface painted is to be covered up after assembling as the interior of built-up columns, bridge chords, etc. The "paint gang" is usually made up of the most inexperienced and cheapest class of labor, and they are taught that the best workman is the one who covers the most iron in a given time. The result is that as little time as possible is spent on cleaning, and often the paint is daubed on over scale, rust and dirt, which completely destroys its value as a protective covering.

FIG. 1.

Some two or three years ago the writer had the opportunity to observe an aggravated case of this kind of carelessness in a structural shop. A plate girder had been sent out of the shop one afternoon just before quitting time, ready for the paint gang to begin work on it in the morning. The painting was done in the shipping yard, and the girder was set upright on skids. These were not quite level, and during the night a thin film of ice formed in the root of the flange angle, as shown in the figure. About noon the next day the inspector discovered that the painter had made no effort to clean this off; and for a length of several feet on the inside of the flange the paint had been spread neatly over the smooth ice. This had begun to melt in the sun, with a result better imagined than described.

Special shapes of girders and columns must be watched with great care to insure proper painting. The girder shown in Fig. 2 was built up with two webs, one straight, and the other curved to a special shape for some unusual construction. The webs were riveted together as shown, and that clause in the specifications requiring "all surfaces in contact to be thoroughly painted before assembling," had been complied with by painting both webs to about the point "X." After assembling, however, it was found impossible to use a paint brush with any effect further in than the point "Y," leaving a length of a foot or more for the whole length of the girder to be daubed

over by the tedious process of using a rag on the end of a stick. A little forethought would have saved time and insured much better work.

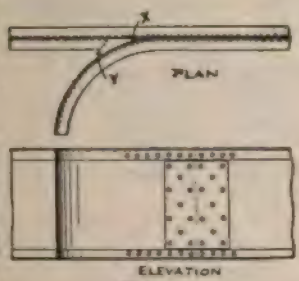


FIG 2.

Much time and thought is spent on the composition and analysis of paints and their adaptability to one use or another. If a proportionate amount of time were spent in determining the most efficient methods of applying it, the output of many shops would be materially increased in value.

Kegs Made of Steel.

A PROCESS of making kegs out of old steel rails has been invented by Joseph C. Heslop, of Joliet, Ill., who believes his invention is to make him wealthy.

In his valise Mr. Heslop carries a small model keg made of polished steel, which he says will within a few years supersede the old wooden kegs. The steel is 1-16" thick, but he claims it will stand three times as much pressure as a wooden keg, and can be made for one-third the price.

The keg is made in two pieces, the joint being hidden by a steel band. The bunghole is hermetically sealed by a patent contrivance, and is graduated to fit any spigot. Any steel can be used, but Mr. Heslop is now using old steel rails. Inside the keg is covered with a pitch preparation to prevent a metallic taste.—*The Technical World.*

Details of a Fire Escape.

IN regard to the ordinary fire escape seen on so many buildings, it might be said that they are nearly all the same as to with and material changing only to accommodate the difference in height of floors.

The full-page illustration shows side view of platform and a few steps, also the detail of the bracket used for parts that are close to building.

Fig. 2 is a detail of a long bracket where two stairs pass or where a plat-

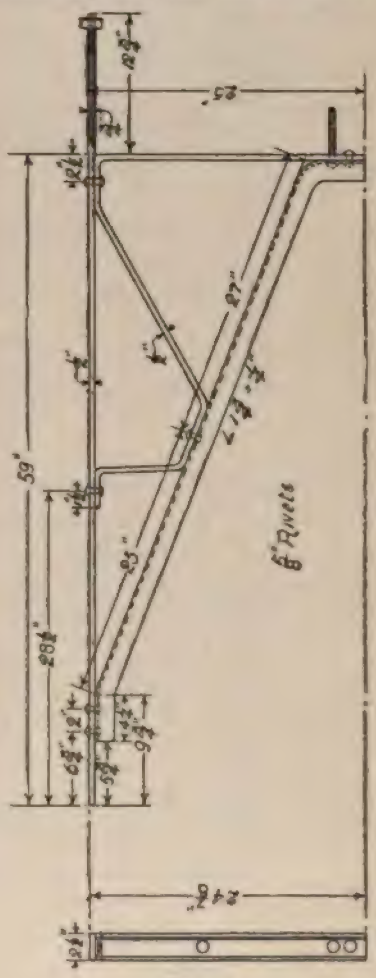
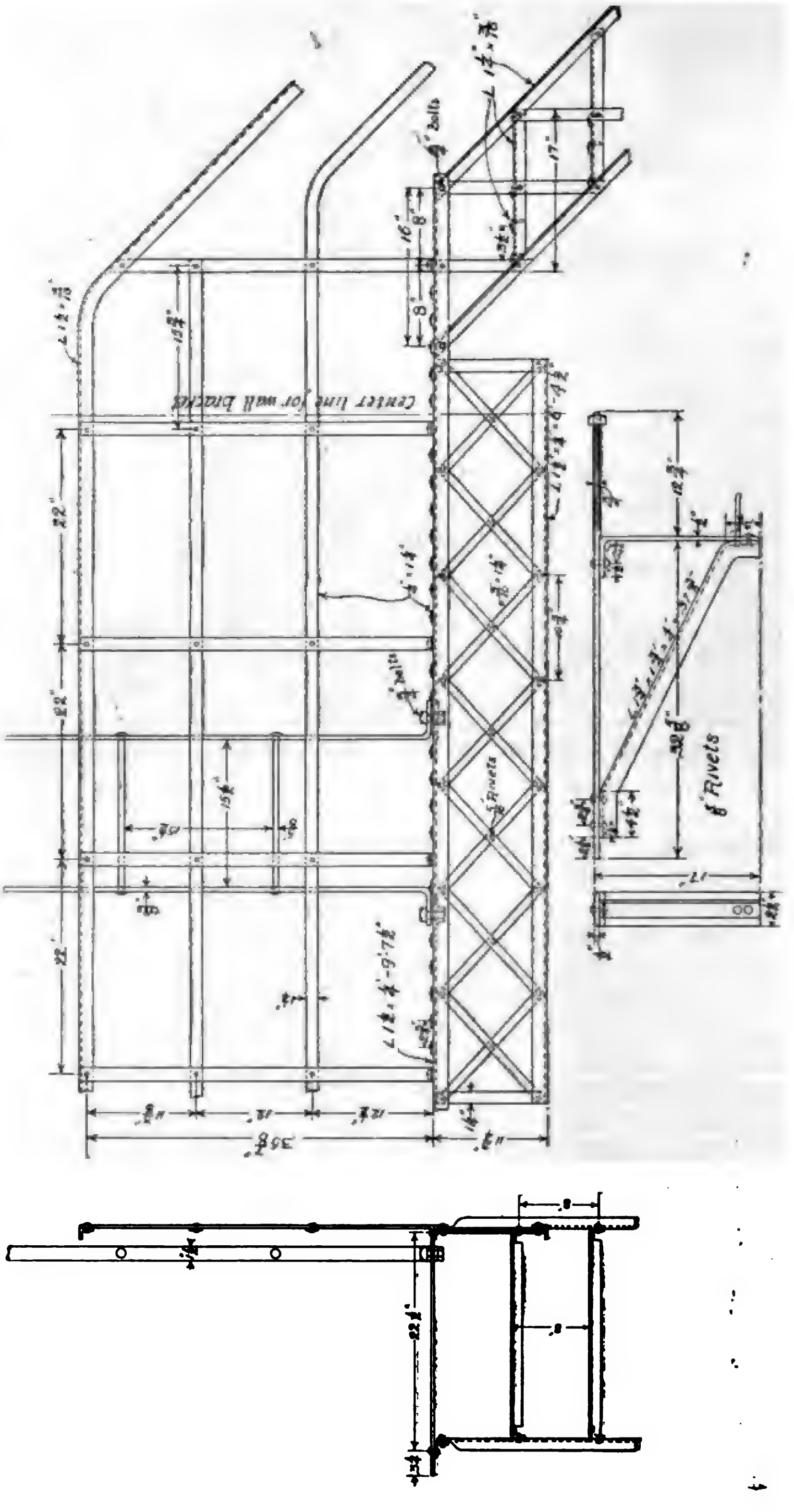


FIG 2.

form is wider. These details are from a stair actually in use, and which would carry all the people that could get on it in a rush to escape.

The ladder should be curved over onto the roof, but not too far off so that people on the roof would not be able to step across.

FIG. 2.



Stresses Applied on Iron and Steel.

Abstract of Paper on the Relations Between the Effects of Stresses Slowly and Suddenly Applied.

By PIERRE BREUIL.

THE author is indebted to the generosity of many of the leaders of the iron industry in France for assistance in carrying out his very numerous tests. He has nevertheless been able to realize only one portion of his program, and all tests were made at the Laboratory of the Conservatoire National des Arts de Metiers.

The slowly applied, as well as the suddenly applied stresses, whose effect was to be compared, took the form of tensile and bending stresses which were exerted upon ordinary bars, and upon bars which had been specially prepared by notching. It was on account of the widely extended practice in France of making tests on nicked bars that the author decided to try and trace the connection between the deformations occurring in these latter and those which occur in ordinary plain bars, and to endeavor to establish the law which governs them.

It seemed to the author that all investigations hitherto made with this object have failed to take sufficient account of the difficulty in which the users find themselves placed, owing to the fact that these new methods of testing have aroused some feeling of distrust of the old methods. He has therefore attempted to establish the transition stage between the two systems, having been instigated by the anomalies with which he has frequently been confronted in carrying out tests on nicked bars.

The material employed was supplied in the form of square bars, the sides of which measured 18 milimeters. These consisted (1) of acid open-hearth steel specimens containing 0.7, 0.45, 0.38, 0.125, 0.12 and 0.10 per cent of carbon respectively; (2) of three qualities of steel manufactured in the electric furnace, containing 0.310, 0.515 and 0.600 per cent of carbon respectively; and (3) of wrought iron of various qualities. These materials were also subjected to thermal treatment, which modified their mechanical properties, the three first steels being annealed, the three next quenched and not tempered, while the remainder, including the wrought iron, were not subjected to any previous treatment. The micro-structure of the steels is shown in plates accompanying the paper.

The machines for the slow tensile and bending tests differed in no respect from those usually employed. They were each provided with an indicator which enabled diagrams to be traced, co-ordinating the stresses with the deformations in the case of all the bars.

The author explains that the object of the idea of notching the bars, which was in order to limit their deformation and show the toughness of the metal by fracturing it across the grain without deforming it if possible, has never been perfectly realized. The various kinds of notching proposed hitherto may without even testing be considered open to criticism, for it is immediately apparent that the metal may undergo deformation in

spite of every precaution. The notches experimentally tried by the author were made with the saw, with a milling machine, with a drill, and with a lathe, and the difficulties attending the cutting of them are pointed out.

Slow Tensile Tests. — For these the notches were made with the saw and with a milling tool on either side of the tensile test specimens, and the depth varied by one millimeter from one bar to the next, the total range being from 17 millimeters down to 5. The notches made with the lathe were left with sharp furrows at the bottom, when the depth was from 17 to 14 millimeters. The diameters of the holes made with the drill was increased a millimeter at a time from 2 to 12 millimeters.

The diagrams of the tensile tests permit the following conclusions to be drawn, the elongation being measured in an uniform length of 80 millimeters.

1. As long as the section of the notch is not small, the total apparent limit of elasticity indicated by the curves remains the same, whatever the form of the notches. This limit is the same as that of the bars without notches (with certain exceptions which the author explains).

2. The diagrams of tensile strength are all similar, but they diminish in height as the notch is deepened.

3. The maximum load of the notched bars referred to the unit of the initial notched section is increased (this accords with the results obtained by other experimenters), but the harder the metal the less is the increase. If this maximum load is referred to the unit of notched section at the moment when this section begins to yield, the value is found to be lower than than that of the actual breaking load per square millimeter of the smooth bar. These two values approximate to each other more nearly the greater the depth of the notch.

4. In the case of ductile metal the unit load is higher the sharper the V of the notch. The opposite is the case with the hard steels, which often break from bending. By drilling the notches the unit breaking load may be made to agree more nearly with that of the plain bars.

5. The contraction in the notch diminishes with the acuteness of the V of the latter, but it varies little for the same same type of notch.

6. The elongation measured upon the curves before they attain their maximum point of elevation includes that which occurs in the notched section and that which occurs in the smooth part of the bar. The elongation occurring after the maximum point of the curve is reached corresponds to the tear in the notch. This tear, which takes place suddenly in the case of hard steels, is relatively slow in mild steel and proceeds in much the same manner, whatever the depth of the notch.

7. The maximum point in the curve of the notched bars occurs at the exact moment when the notch begins to crack, and has no analogy with that of the smooth bars except in the ultimate yield point.

8. The amount of work expended in producing the rupture of notched bars is influed by the two factors contributing to it (the stresses and the elongations), and it consequently varies greatly, according as the type of notch varies.

Summing up, it would appear from these tests to be necessary, in order to arrive at a uniform qualification of all metals from the point of view of tests with nicked specimens, to make the notch in such a manner that the ultimate load in bending should always be less than the limit of elasticity in the smooth portion of the bars. This would involve varying the notch with each kind of metal, for instance, in the case of mild steel, the bars should be nicked to a depth equal to half the initial section, and in

that of hard steel, to a depth equivalent to one-third only. If this condition is fulfilled, it may be assumed that the results of the tests upon nicked bars are in reality of the same order as those of tests upon plain bars, but much less clear and precise. Under these circumstances, why should the bars be nicked at all?

By experimenting with a series of polished bars the author was enabled by observing the lines representing the distribution of the deformations described by Hartmann to note that in the nicked bars the deformations began at the point of minimum section under a unit load exactly equivalent to the unit limit of elasticity of the smooth part of the bar. The raising of this limit was only apparent, as one might have been led to expect from the diagrams. The deformation in the neighborhood of the notch is localized in those parts of the bar, the volnme of which varies with the notch, which parts, however, are deformed in the same manner if the same type. The volume affected by the deformation varies approximately as the square of the distance between the bottom of the two notches when they are cut with a saw or with a milling tool.

In general the fractures of the notched tensile specimens follow the lines of Hartmann, the surfaces at the point of rupture being fibrous or granular, which seems to indicate irregularity in the distribution of the stresses in the metal. The mild steels are the most characteristic in this respect, while the hard steels almost always show a granular fracture, photographs of which are appended to the paper.

Slow Bending Tests. — The notches were made with a saw and a milling tool on one side only of the bars, and they were bent on two supports, a distance apart in one instance of 80 millimeters, in the other of 100 millimeters, and the notches varied in depth from one to seven millimeters. For purposes of comparison planed bars of the same metal, having a thickness equal to the nicked bars at the bottom of the notch were also bent. The results of the test are graphically represented in a large series of diagrams, and may be briefly summarized as follows:

1. All the bending curves for one kind of metal were similar, and as in the case of the tensile tests, the curves for the notched bars are fractions of the curves for smooth bars of the same thickness. A V-shaped notch with a milling tool arrests the curve more quickly than one cut with the saw, but the characteristic outline of the curves remains the same.

2. The curves of the smooth bars show that the limit of elasticity is in accordance with the laws of the resistance of materials.

3. The curves of notched bars reach a maximum at the moment when the first crack manifests itself at the bottom of the notch, but the latter is not completely cracked up to the edges until somewhat later. This point is generally marked by a sudden fall of the curve. The phenomena are particularly clearly marked in the case of mild steel, while with the hard metals rupture takes place at the moment the notch begins to open out. Strictly speaking, mild steels do not break at all even when very deeply notched, so that to classify them exactly is a difficult question.

4. The slightest deviation of the knife edge of the bending press outside the plane of the notch modifies the appearance of the first cracks, and may lead to results which are by no means an indication of the quality of the metal.

5. A very considerable amount of friction occurs between the bars and their supports, which modifies the form of the curves and influences the result of the tests.

6. The contraction of the notched bars diminishes as the notch is enlarged, but only slightly.

7. The work necessary for producing rupture is not without significance but only in so far as it is applied at the point of notching. Up to the maximum of the curves, however, the work includes that expended in bending the portions of the bar outside of the notched section.

8. The only work which need be taken account of in determining the value of the metal from the point of view of tests with notched specimens is that which is expended after the curves have attained their maximum. But since rupture does not occur in the mild steels it is difficult to obtain an exact criterion.

9. In order to confine the deformation entirely to the notch, care should be exercised to cut less deeply, the harder the metal under investigation, owing to which necessity, however, complications are apt to ensue.

The conclusions to which the author has been led by the study of Hartmann's lines are analogous to those drawn by him from the results of the tensile tests.

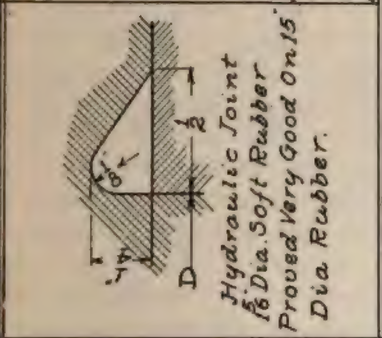
The fractures of the bent bars, whether smooth or notched, resemble very much those of the tensile test specimens.

Compared with mild steel, the wrought iron shows a certain superiority in the bending tests with notched bars. The crack successively meets with the laminations which themselves crack and cause the bar to behave much in the same manner as a number of plain bars superposed. The number of bendings and the work expended in the case of the iron are consequently greater than in the case of mild steel.

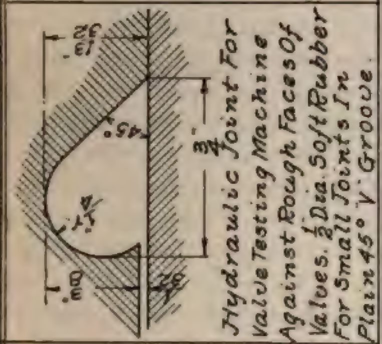
Impact Bending Tests.—All the impact tests made by the author were carried out with a drop-hammer of ten kilogrammes weight. The factors specially investigated were the height of fall and the depth of the notches. The work expended in producing the flexure both of the plain bars and of the notched bars was measured exactly by determining the amount of work in excess. The distance apart of the supports was uniformly 100 millimeters, and by taking a few precautions the tests gave excellent results. After each successive blow of the drop-weight the bars were laid on a sheet of paper, and the set due to the blow was measured. The results of the tests on the plain bars showed that for an *apparently* equivalent amount of work the set *apparently* diminished when the height of the fall of the drop-hammer was reduced. But on calculating the amount of work expended on the bars and their supports it was found that the same amount of set was produced by the same expenditure of work. This law is general; and, besides, the work performed in dealing the blows is just about equal to the work expended in the slow bending tests. The results with the nicked bars therefore, lead the author to the conclusion that it is inadvisable to summarily reject the slow bending tests, which have long been established and give more exact results than sudden bending tests.

Conclusion.—The conclusion to which the author ultimately arrives is that the nicking of test bars simply implies the introduction of an additional complication, and he questions whether the numerous discussions which have taken place upon this subject can be justified, in view of the fact that the ordinary tensile and bending tests when properly interpreted yields results much less open to criticism than those with nicked bars.—*The Iron and Steel Magazine.*

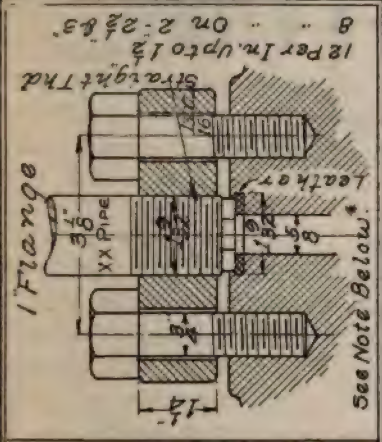
This illustration is carried over from article on page 36, on "The Design of a Stuffing-Box."



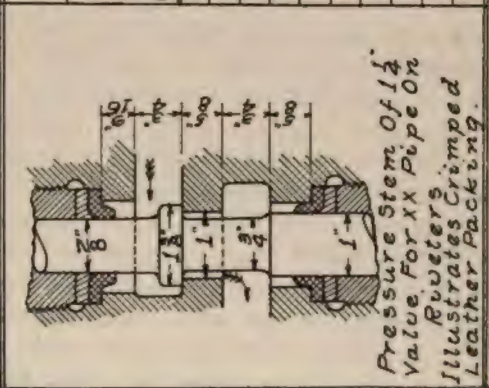
Hydraulic Joint $\frac{5}{16}$ Dia. Soft Rubber Proved Very Good On 15" Dia Rubber.



Hydraulic Joint For Valve Testing Machine Against Rough Faces Of Valves. $\frac{1}{2}$ Dia. Soft Rubber For Small Joints In Plain 45° "V" Groove.



See Note Below*



Pressure Stem Of $1\frac{1}{4}$" Value For XX Pipe On Riveters. Illustrates Crimped Leather Packing.

ORDINARY GLANDS FOR HEMP PACKING DIFFERENT COMPANIES.

DIA. RAM.	DEPTH OF PACKING	THICKN'S OF PACKING	NO. OF RINGS SQUARE	SIZE OF STUD	NO. OF STUD	BOLT CIRCLE	THICKN'S OF FLANGE	LENGTH OF GLAND	WORKING PRES-SURE'D	MATE-RIAL.
$9\frac{3}{4}$	4	1	3	$1\frac{1}{4}$	4	$14\frac{1}{2}$	$1\frac{1}{4}$	3	1500	S.C.
$2\frac{3}{4}$	3	$\frac{3}{4}$	3	1	2	$6\frac{1}{2}$	$1\frac{1}{4}$	$2\frac{1}{2}$	1500	C.I.
$16\frac{5}{8}$	$4\frac{3}{4}$	1	4	$1\frac{1}{4}$	10	$21\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1500	S.C.
$4\frac{1}{8}$	$3\frac{1}{2}$	$\frac{3}{4}$	4	$1\frac{1}{8}$	2	8	$1\frac{1}{2}$	1	1500	S.C.
4	4	$\frac{5}{8}$								
10	6	$1\frac{1}{16}$								

* FAR MORE APPROVED FORM SEE TIGHT JOINT COS. CATALOGUE.

FEB. 1, 1904. DF. ARNER.

Formula for Crown Thickness of Masonry Arches.

A WRITER in *Engineering News* offers the following formula for the thickness of crown of arch in feet:

$$d = \frac{1}{8}\sqrt{(S-R)\,10+2H}$$

Where

S = Span of arch in feet.

R = Rise of arch in feet.

H = Depth of surcharge over arch in feet.

d = Thickness of arch at crown in feet.

HOME STUDY.

Mechanical Drawing.

CHAPTER VI.

Riveted Joints.

RIVETED joints may be divided into two general classes,—lap joints where the two joints lap over each other, and butt joints where the two butt together and are joined by over-lapping straps or welts. Butt joints are generally used where the plates are over ½" thick.

Any joint may have one, two or more rows of rivets and hence be known as a single-riveted joint, a double-riveted joint, etc.

Any riveted joint is weaker than the original plate because holes cannot be punched or drilled in the plate for the introduction of rivets without removing some of the metal.

Fig. 1 is a single-riveted lap joint. Figs. 2 and 3 is a double-riveted lap joint. Fig. 4 is a single-riveted butt joint. Fig. 5 is a double-riveted butt joint. Fig. 6 illustrates a joint in common use known as diamond riveting, the spacing in the outer row being twice that of the other rows. Figs. 5 and 6 show joints with inside and outside welts.

Plate IV in this course is to show a steam receiver which was attached to a high pressure marine boiler. The shell and ends are made of steel boiler plate, the stay bolt is of soft steel, the fittings are steel castings and the rivets are steel.

Shell 3'-6" diameter and 9'-0" long outside.

The shell is fastened together lengthwise with a double riveted lap joint, and the ends are fastened to the shell by single riveted lap joints. The steam connection is made to fit the curvature of the shell and is riveted in place, the hole in the shell being reinforced on the inside with a collar of ⅜" plate.

The stay bolt is fastened to the ends by nuts, one on the inside and one outside having packing washers underneath. The object of this bolt is to take part of the load away from the end rivets and to stiffen the ends. In this case, the rivets have been assumed to carry the load on a ring five inches wide around the end, and the bolt carries the rest of the load due to the steam pressure on the end. The bolt is upset for equal strength throughout. Tables of standard upsets can be found in the hand-books, Carnegie, Cambria, etc. The nuts are standard for the diameter of bolt at the upset.

The work required on this plate is to lay out the side and end views of the receiver at about 1" to the foot, and make details of the castings including the manhole, also the stay bolt.

Symbols used in this chapter:

D = diameter of shell in inches.

p = pitch of rivets in inches.

P = steam pressure in lbs. per sq. inch.

d = diameter of rivets in inches.

t = thickness of of plate in inches.

T = safe tensile strength of steel = 12,000 lbs. per sq. in.

First consider the longitudinal joint of the shell; take a ring of width equal to

the pitch p, then the stress due to the steam pressure, tending to tear the plate on one side and rupture the joint on the other is (1) $D \times p \times P$.

The reason for this will be seen by referring to Fig. 6 where the arrows represent the direction that the steam pressure is assumed to take. (It actually acts radially around the shell.)

which represents the force resisting the pressure. Expressions (1 and 2) are equal if the shell holds.

Then $DpP = P + (P - d)tT$.

If we assume ⅞" to be the diameter of the rivets and make $p = 3d$, which agrees fairly well with practice, then substituting numerical valves and taking steam pressure equal to 160 pounds per sq.

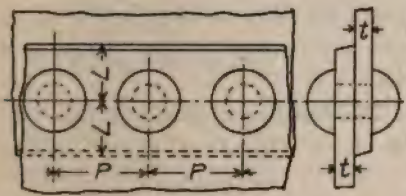


FIG. 1

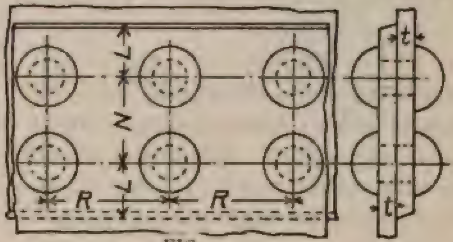


FIG. 3.

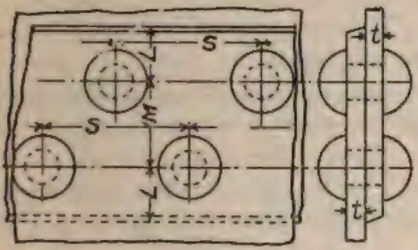


FIG. 2.

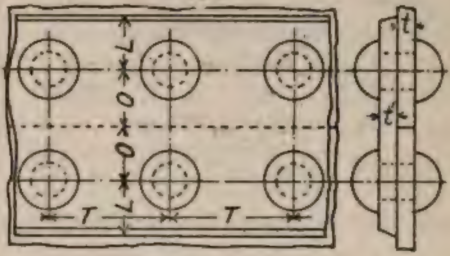


FIG. 4.

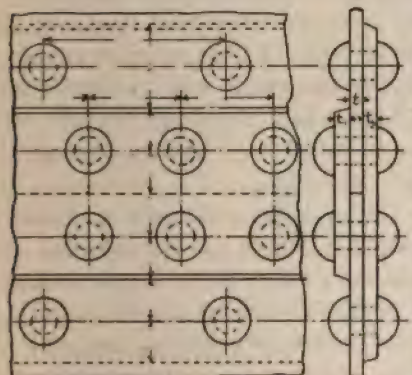


FIG. 5.

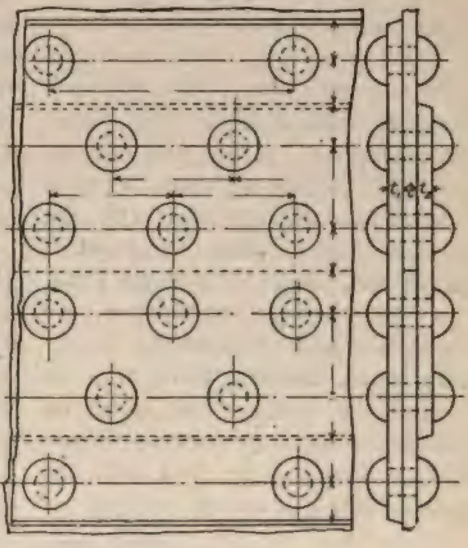


FIG. 6.

Since there are two sides of the ring resisting the pressure, one of an area equal to the thickness of the plate, t, multiplied by the width of the ring P, the other $= t\ (P - d)$, we have the formula (2): $P + (P - d)\ tT$,

inch we have $42 \times 2.625 \times 160 = 2.625 + (2.625 - .875)t \times 12{,}000$. Solving for t we have

$$t = \frac{17{,}600}{52{,}500} = .295$$

The nearest size of stock plate is $\frac{5}{16}''$ thick. Suppose we make the shell $\frac{3}{8}''$ thick, which will allow a little additional margin for safety.

Again, the steam pressure, besides tearing the plate through the rivet holes, will crush the plate in front of the rivets. The crushing force will be

$$\left\{ (4)\ \frac{DpP}{2} \right\}$$

because this force is exerted on the rivets at one end of the diameter only, the other end being solid plate. The force which opposes the crushing is (5) $2dt \times 20{,}000$ where 20,000 is the safe crushing strength of the plate.

Putting (4) and (5) equal,

$$2dt \times 20{,}000 = \frac{DpP}{2}$$

Substituting numerical values,

$$2 \times .875\ t \times 20{,}000 = \frac{42 \times 2.625 \times 160}{2}$$

(2d is used because of the double riveting, *i.e.*, two rivets in one pitch distance.)

Solving for t: $t \times .252$.

This shows that a $\frac{3}{8}''$ plate is amply strong to resist crushing. We can check this result in another way. "In Carnegie's Pocket Book," p. 195, the bearing value of a $\frac{7}{8}''$ rivet in a $\frac{3}{8}''$ plate is found to be 6570 lbs., and since there are two rivets in each pitch distance this becomes 13,140 pounds. But the crushing force, $DpP \div 2 = 8825$ pounds, therefore we are well inside the limit of safety.

This joint can fail in a third way by shearing off the rivets. The stress on two rivets is 8835 pounds as before. Again from Carnegie we find that one $\frac{7}{8}''$ rivet in single shear at 10,000 per sq. inch is worth 6010 pounds. Two rivets then are worth 12,020 pounds, which is ample.

Now take the ends of the receiver and assume for convenience that they are also $\frac{3}{8}''$ thick, and make the diameter of rivets and the pitch the same as before. If the rivets are assumed to carry the pressure that comes on a ring 5″ wide the load upon them will be

$$3.1416 \times (42-5) \times 5 \times 160 = 92.800,$$

where $3.1416 \times (42-5)\ 5 =$ area of the ring.

The number of rivets in this joint will be:—

$$\frac{3.1416 \times 42}{2.625} = 50$$

The net area of the plate to resist tearing equals

$(3.1410 \times 42) - (50 \times \frac{7}{8}) \times t = 33$ sq. in. about, where $t = \frac{3}{8}''$ as assumed.

Then $92.800 \div 33 = 2820$, about.

This is much smaller than might be used with safety.

It will be noticed that we have used the whole number of rivets in the joint instead of the number in a pitch distance. This is a matter of convenience, as the result would be the same in either case.

The student is left to work out the crushing and shearing strength of this joint, which may be done just as in the previous joint.

The stay bolt will now be designed to take the part of the end load not already taken by the rivets. To do this, put the load that comes on the rod equal to the safe tensile strength of the rod which may be taken as 12,000 pounds per sq. inch.

Then solve for the diameter of the rod at root of thread.

ARCHITECTURAL.

Wind Pressure on High Buildings.

PROBABLY no person unaccustomed to such an experience ever stood on the roof of a 20-story building, when a great wind was blowing without a tremor of the nerves, and at least an imaginary sense of swaying in the huge structure beneath his feet. There is such a swaying, and it has been measured with great exactness. But it turns out to be far less than imagined. Experiments and mathematical calculations, of which the general public can have little idea, have determined the pressures exerted against lofty structures by winds of various velocities, and also the best methods of enabling the buildings to withstand these pressures. When a building 200 feet tall sways only a quarter of an inch out of the perpendicular in the face of a hurricane dashing against it with a force of 30 pounds on every square foot of its surface that is a testimonial to the success of scientific "wind-bracing." People who sit secure and indifferent in the offices 200 or 300 feet above the pavement and hear the wind howl and hurl its blast about the steel cage that incloses them think little on the mathematics were not the surest product of the human mind. they might find themselves at the bottom of a tangled wreck. In a scientifically constructed building the force of the wind pushing against its upper portions arouses a resistance which is transmitted downward from story to story, and is distributed on all sides from member to member of the steel skeleton, until it is felt at the foundation, and thus the strength and weight of the lower portion of the building, lying in the shelter of the surrounding edifice, out of the reach of the wind above, are brought into play for the common defense, very much as the effects of a push against a man's shoulder are distributed throughout his muscular system, down to his feet and are thus resisted by his whole body.

Carrara Glass.

A MATERIAL which, as its merits and possibilities become better known is attracting more and more attention on the part of architects and builders is what is called Cararra glass, a new product which has the appearance of polished marble, and which is especially adapted for wainscoting and walls in bathrooms in private dwellings, where its non-absorbent properties render it unequalled. The product is furnished in white and black, is impervious to all liquids and will not, therefore, stain.

Fire Destroyed Ship Drawings.

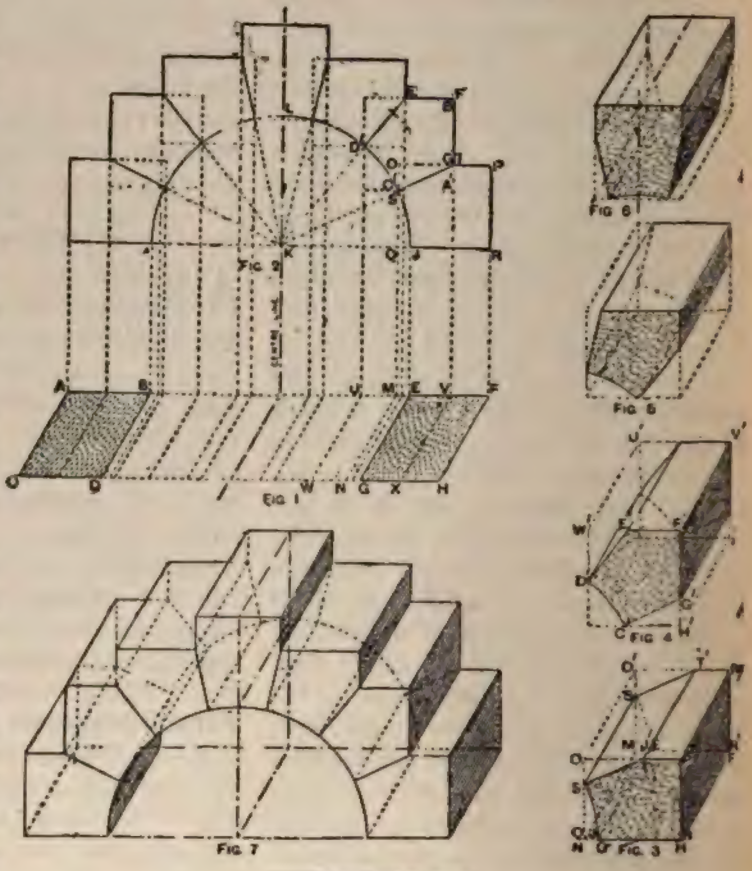
Fire destroyed the chart room at the Cramps' shipyard Feb. 2 and did damage of about $25,000. The building contained the working plans for the new battleships Idaho and Mississippi, two Clyde line ships, the revenue cutter Galveston and a Venezuelan government boat, the Espanza.

The flames are supposed to have originated from a burning cigar stump carelessly dropped.

Setting Out a Skew Arch.

By W. C.

THE accompanying illustrations show a simple way of setting out and working the voussoirs of an oblique or skew arch. The figures are really self explanatory, but the following brief description should remove all difficulty: Let A B C D and E F G H (Fig. 1) be the plan of an oblique or skew arch, the parts A B C D and E F G H representing the under side of the springing course. Project the points B E so that they will cut a line drawn parallel with B E in the points I J (Fig. 2). The distance between I and J gives the diameter of the arch. Bisect the line I J in K, and with radius, I K, describe a semicircle, I L J, which represents the intrados of the arch. Divide the semicircle, I L J, into seven equal parts, corresponding to the proposed number of stones in the arch,—that is, six voussoirs, three on each side, and the keystone. Draw the joints on the face of the arch converging to the center, K, from which the arch is struck, and completed the front elevation of the arch, as shown in Fig. 7, or as required. Also draw horizontal and perpendicular lines (shown dotted to avoid confusion) from the salient points of each stone as shown in the figure. The perpendicular lines are dropped from the salient points of each stone and pass over the base line of the arch, as represented by I J, until they cut the line A F in the plan (Fig. 1), from which line they must be taken across to the line C H at the same angle as that at which the arch is inclined. These lines afford facility in measuring the widths of the arch stones. The



SETTING OUT SKEW ARCH.

Through all the coming generations

ILLUSTRATING.

The Psychology of Advertising.

Demonstrating practical suggestions in expression and Ad characteristics

By CHARLES C. RIESTER.

INDUSTRIAL progress at the present day, with profitable business appliances can be inaugurated and perpetuated with facilities that would have been incredible to our ancestors, and the judicious use of writing with well merited judgment is probably the most valuable and most available progress of universal industry.

The sumptuary laws of the middle ages, which were made to restrain common people from imitating the dress and equipage of the nobility, invoked a desire in the different lines of enterprises to carry out their imitative plans which gave them almost the same prestige as the nobility; hence, the application to their enterprises.

The wheels of commerce are kept in constant revolution by the untiring work of ad writers, who seem to keep the whole sea of humanity posted on the general merchandise, which keeps the competitors scheming for new ideas to attain the public's good will and patronage, hence the attractive work of the ad man.

The value so destinctive in the art of printing by well defined literature is the present mode of publicity, which merits the expression given to us and to hold our attention while creating a desire.

It is only by long experience and close touch with commercial illustrating that an artist can portray in an artistic sense the practical requirements for a design.

The many activities of industrial pursuits readily lend themselves to representation by symbol.

"Art is the external manifestation of the idea, the revelation of the invincible reality through the senses." This comprehensive, yet simple, definition of Lilly's, which should apply to all designs when portraying by symbol or allegory, the theme of the work in a manner simple, effective and artistic, adding the touch that gives it value.

It requires great skill and care to evolve such a design; a too flippant idea may tend to degenerate it into an absolute absurdity when its true strength should be in its artistic dignity and the subtle force of strong suggestion portrayed in some unique manner.

Originality of expression attracts attention immediately and if the remainder of the design possesses sufficient force to hold the mind from wandering to other subjects, while the eyes are engaged in viewing it warrants the quality with which the originality of the designer's best efforts are put into play.

Now it does not always happen that a designer has the same individual expres

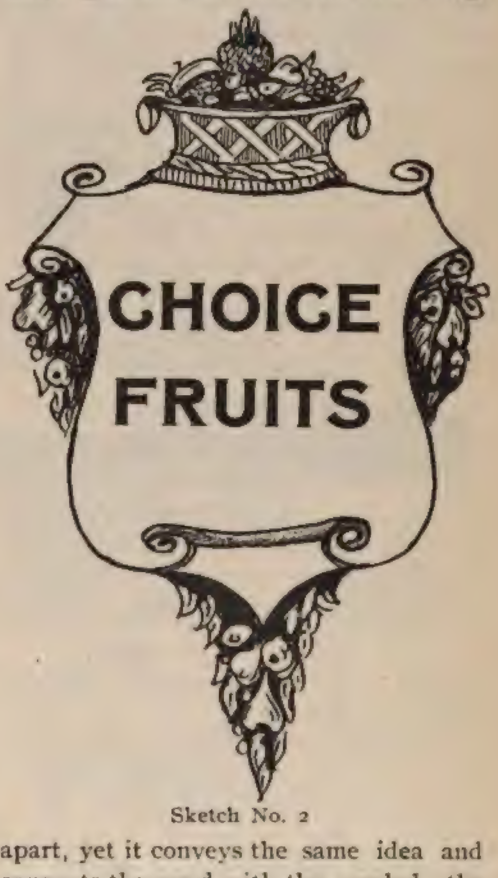
sion as others, there may be that which changes the entire mode of his illustration; the choice and method must be entirely to his judgment only after he has made up his mind what the article may be. After having settled the design in the imaginative he should trace or rough it out in pencil, just enough to set the

Sketch No. 1

idea clearly before the eye.

Just what should constitute perfection is hard to define? but it can not be amiss to say that this can be reached directly by one word—simplicity.

Simplicity in arrangment does not mean severity in plainess, but rather such balancing contrasts and colors that will tend to produce harmony, for example: see the illustration No. 1. This is an announcement of a seed store "The Garden" which I would use as a suggestive illustration. The first thing which meets the eye is the head and the symbol. "The Garden" (words) will at once give you the information desired, the symbolic flower pot and the head are two things



Sketch No. 2

apart, yet it conveys the same idea and connects the word with the symbol—the symbol with the word.

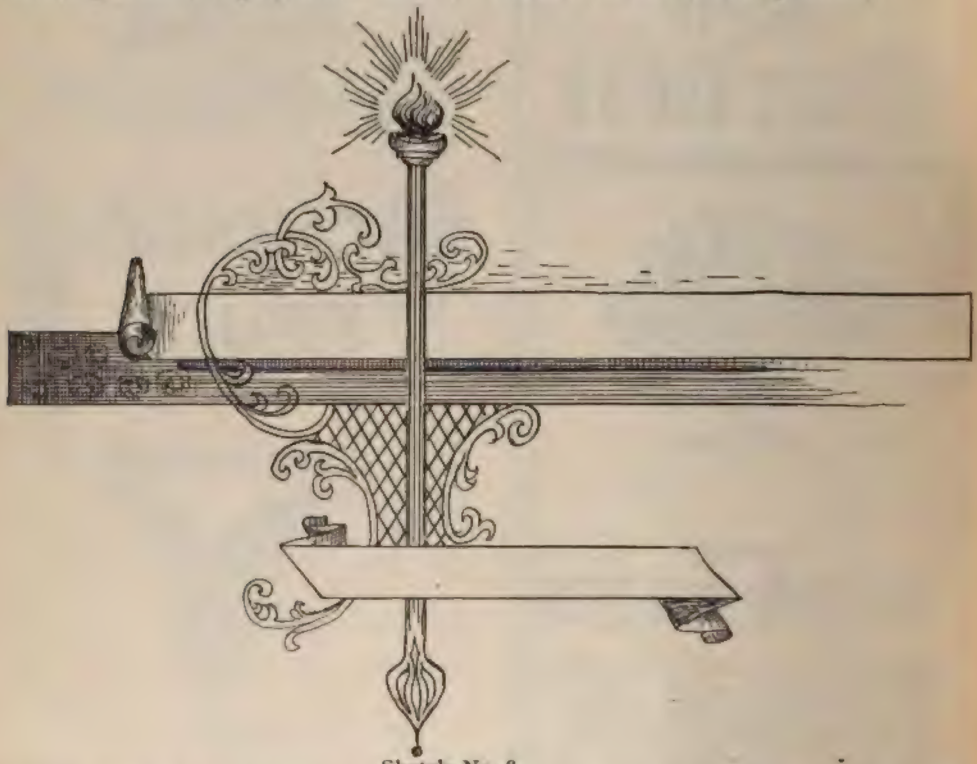
Much depends on the neatness of the card for display or cover for a catalog, after gaining the attention the reading matter should be chosen carefully and the arrangement so as to create a desire. A black on white will always be more predominant when set in a clear space of white background with abundant margin to offset the design, care should also be

taken in the blending of too many colors which blurs it and makes reading harder when at a distance from it.

My example No 2 is a design, where good coloring will not be wasted. This design is a common shield with a basket of fruit for its heraldic device on the top, on the sides and bottom are bunches of "Choice Fruits." These two words specifies the whole variety of the fruit family, and will at once appeal to the eye. This design can be highly illuminated so to bring out the full richness of the fruit, which will make one desirous of buying. Whereas you take a design as in No. 3 you lack the suggestion, should you use it for No, 1 and 2. But, should you like to use a design like this for a tint block to improve the title of a concern or use for commercial scroll work on office stationary, this would be appropriate in some cases.

Now you will see in both cases the method of procedure is direct and simple, furthermore it leads right to the spot and is the A B C of good judgment. It is in stepping beyond the present to strive for the coveted goal for the expression of individuality that one either meets with success or spoils his design by lack of effort to be original.

Each of the large commercial houses must have at the head of its advertising department a man of wide experience, one who has a keen appreciation of the true value of all methods of publicity.



Sketch No. 3.

He should be a writer, should have served his apprenticeship as a printer, to know the different styles and sizes of type (not to specify a 24 point type as an 8 point which has been done by a Chicago ad man of a recent new publication), he should be an illustrator of repute, and should not try to put two pages of reading matter into a quarter page ad of a standard magazine size.

Upon this and many more points of good generalship depends the success or

failure of such a house.

A desire to have, a possible unconscious appreciation, a longing for, a feeling which is attained by the producing of thought on printed matter, to promote a sale must be so impressive in its own originality as your own persuative voice.

The Spotless town of Sapolio, the Sunny Jim of Force and the Gold Dust Twins etc., leans to individual successes of the deep thinking ad man.

Lessons in Illustrating

The Perfect Head.

By R. W. MAGEE.

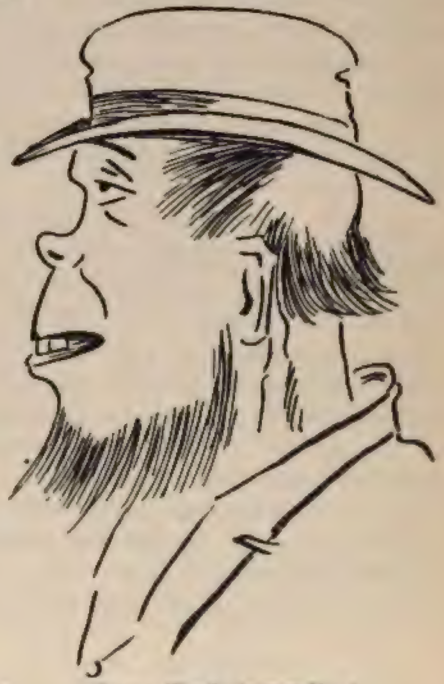
NO feature is of more importance to the illustrator than the study of the head, and none is more difficult. It is the chief organ of the human figure, which is the noblest object of creation. With a full and serious realization of the subject now before us, let us begin.

Study the heads of the masses of people about you. Note carefully the outline, proportions and individual features of each, and then answer the following:

Ex. 1. The Perfect Head.

1. Do you find them all alike?
2. Do you find any alike?

To both questions you answer, No. What, then, must we conclude from the observations? It is this: That all heads differ from each other in some particular, and that each has an individuality of its own.



Ex. 2. The Caricature Head.

Since, then, all natural heads differ in proportions and structure, it is evident that we must study them and learn to represent them as they really are. Your work as a coming illustrator is to repre-

sent what you see in the most truthful and accurate manner.

In the leading art museums of this and other countries are found many plastic reproductions of the antique heads (heads of ancient gods). These heads we call perfect or ideal heads because they were so considered by the ancient sculptors who made them. They exhibit all the beauty and symmetry of proportion that the masters hand of the artists could bestow upon them. It is these antique or perfect heads we wish to consider in this lesson.

These heads being modeled according to a fixed code of of proportions, our first step is to ascertain what these proportions were that the ancient sculptors adopted and so faithfully observed in their work. Different ages have brought forth different codes of propoportions, but we will consider the one most generally considered reliable. These proportions relate to the entire human figure, but, we will consider only those of the head at this stage of the work.

Exercise 1 illustrates the following proportions: The distance from the tip of the chin to the top of the crown constitutes the height of the head. A straight horizontal line passing through both eyes shows the greatest width. The outline of the head might be represented as egg-shaped. Notice that the head from the top to bottom is divided into four equal parts. Beginning with the lower point of the chin the first division extends to the bottom of the nose. The second division extends from this point to the top of the nose. The third division occupies the space between the top of the nose and the top of the forehead or the roots of the hair, whence the fourth division runs to the crown of the head.

Notice also that the greatest width of the head (the distance across the eyes) is divided into five equal parts, the second and fourth parts being occupied by the eyes.

The eye is taken as the unit of measurement. The mouth is one and a half times the length of an eye. The mouth in profile is half as long as in front view, but is the same in height. The nose is an eye in width and two in length. The ear is two eyes in length and one in width. The ear occupies the same space in height as the nose.

The lower division of the face is divided into three equal parts, the mouth being one-third of the distance from the nose to the tip of the chin.

Now let us consider the practical side of this lesson. You are training for the profession of illustrator. Of all the heads and faces you may be called upon to draw, not one of them is ideal. Not one head in a thousand conforms to the proportions of the ideal. Draw, then, as you see, and refrain from idealizing.

It is important, however, that you should be familiar with the proportions and characteristics of the ideal head, that they may serve you as a guide and be a strong stimulus to well-directed effort.—*Penman's Art Journal.*

CURRENT TOPICS.

What we get in the Mail?

THERE are a great many things that come to us in the mail, the most important of which is money.

This comes in all shapes and sizes, and we take it when it arrives—only a few times has the envelope reached us alone.

Money is often loose in the envolope, a very, very unsafe way to send it; then it is often wrapped which is generally safe.

One time we received an envelope with a ragged hole in one corner, but the coin (50c. piece) missing. It had been fastened in a coin card and deposited in a mail chute at the top of a 14 story building and in falling the coin cut through and an employe of Uncle Sam got it; we did not.

Small amounts are safe if well wrapped but stamps are a better means of sending such remittances.

One subscriber cut a circular hole in a square piece of pine and inserted a quarter then inlaid the piece of pine and writing the order on one side and the address on the other with a stamp sent it to us.

That was tempting the post office employees more than the loose coin in the envelope for in the latter case it is no trick to shake the coin through the thin paper.

Then we get a great many letters with no city or state address in them and if it were not for the post mark on the envelope we would only have to wait until the writer sent in a kick.

This is more than some do, for we have letters in this condition, but no kicks have been entered, and we suppose that the fellows think us a cheap crowd.

We are very careful now to answer promptly where there is money sent, and hereafter will watch this very closely.

When you send coin see that it is well wrapped, and be sure to give town and state address.

Machine Shop Philosophy.

Telling tales out of school is no worse than telling tales in the shop.

Oftentimes the man who gets in first in the morning is the last one to go to work.

The two-foot rule is all right in its place, but its place isn't in the machine shop or drafting room.

The coporations who have "done away with the 'prentice boy" are the ones who are finding fault with the "modern" machinists.

The man who puts a groove in the grindstone ought to be relegated to the deep, deep woods.

It isn't what you WERE in some other shop, its what you are NOW that determines your worth to your present employer. —JOE CONE.

Our Supplements.

The supplement in the Jan issue was made up of matter supplied by Mr. Roy Bradly and from a page in the American Bridge Co. Hand Book.

The next one will be a double one in our March issue.

YOUNG Man, don't wait for something to turn up,—turn it up yourself.

SOMEONE has said that a person is just as old as he is in experience.

Three Classes of People.

SOME from whom much is heard but nothing happens.

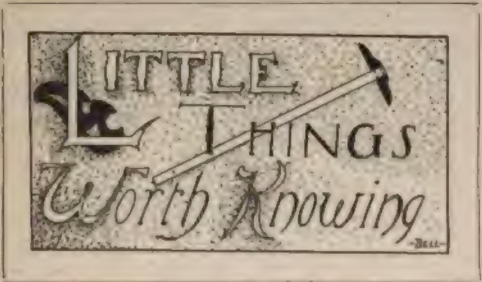
Some from whom nothing is heard and from whom nothing happens.

Some from whom little is heard, but from whom much happens.

Push 'Em.

GEN. GRANT once telegraphed an officer for a report of his progress, and he replied, "Doing well, but things should be pushed."

Grant sent him this: "Then push them."



Late estimates place the population of the world at 1,503,300,000.

In India native laborers receive four cents a day for sixteen hours' work.

The highest elevation in Missouri is Iron Mountain, which is but 1,800 feet above the level of the sea.

Florida has imported from China the rice paper tree, which is so interesting and valuable in the latter country.

Paris is shortly to have a school in which people will be taught to sleep properly,—with closed mouth, limbs restfully placed, etc.

If the navies of the world were massed in one monster fleet there would be 560 battleships, 471 cruisers, 1,255 gunboats and 1,600 torpedo craft.

Two years of every three in Korea have twelve months each of twenty-nine or thirty days, and the third year has thirteen months with 385 days.

Silesian glass makers are turning out glass bricks for all sorts of building purposes, and glass houses of a very substantial kind can be built now.

A gold nugget weighing 120 ounces and valued at $2,000, recently picked up at a placer mine in Park county, California, is said to be one of the largest ever found.

Timber sleepers to the number of 1,494,000,000, and valued at $900,000,000 are in use on the railways of the world, and make a serious drain on the available timber supply.

There is only one telephone for every sixty families in London, according to the latest statistics, while in New York there is one for twelve, in Boston one for six and in San Francisco one for four.

Welding by electricity has been brought to such a state of perfection that apparatus can be carried to a railroad track and two rails joined as solidly as if they had come out of the rolling mill one piece.

Why He Wasn't Promoted.

He watched the clock. He was always grumbling. He was always behindhand. He asked too many questions. His stock excuse was "I forgot." He wasn't ready for the next step. He did not put his heart in his work. He learned nothing from his blunders. He chose his friends among his inferiors. He was content to be a second rate man. He ruined his ability by half doing things. He never dared to act on his own judgment. He did not think it worth while to learn how. He thought it was clever to use coarse and profane language.

A Parabolic Reflector.

THE reflector for the lights used in blue printing by electricity or for a headlight should be more than merely a flat sheet or even of a part of a circle, because the rays of light are not thrown in a manner to give the best of results. It has been found that a shape of the same curvature as a parabola will give the rays of light the proper direction, and that the lamp must be set at a certain point.

A parabola is a curve generated by a point moving in the same plane so that its distance from a given point (F) shall be constantly equal to its distance from a given right line (AB).

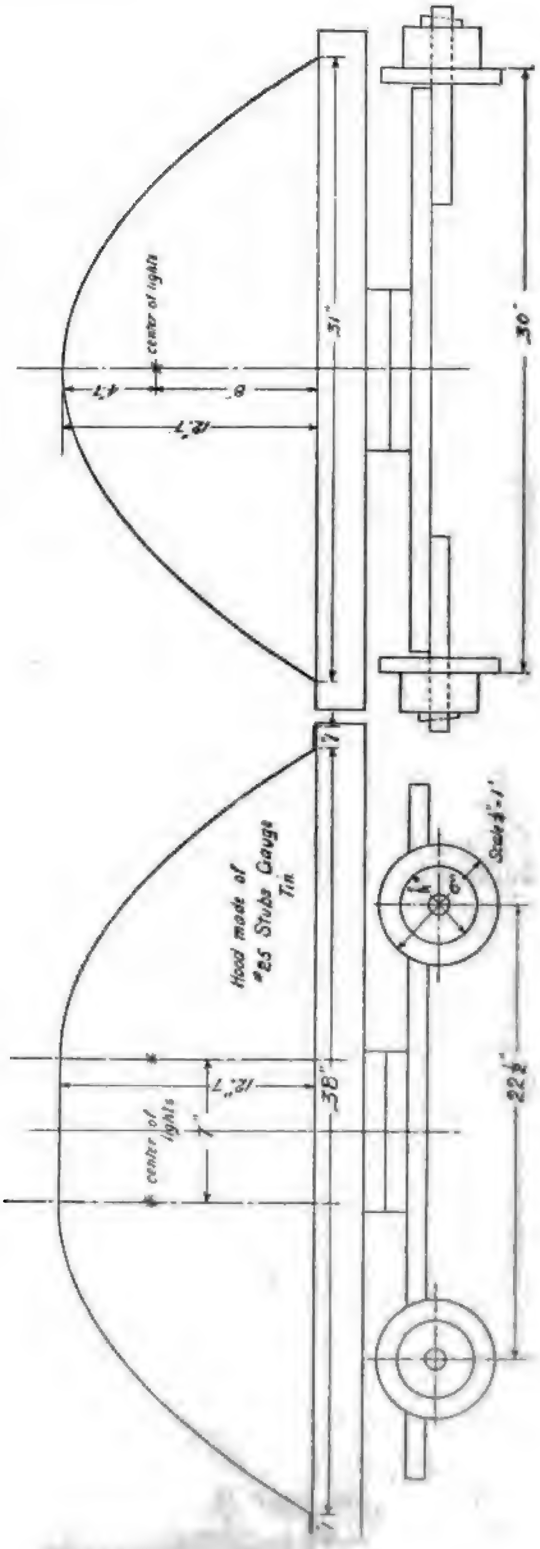
The given point is the *focus*; the given right line the *directrix*.

If through the focus (F) a right line (CD) be drawn perpendicular to the directrix (AB), it is the *axis* of the parabola, and the point in which this axis intersects the curve is the vertex (V).

Then FV will be equal to VC, and any point in the curve will be the same distance from F as it is from the line AB.

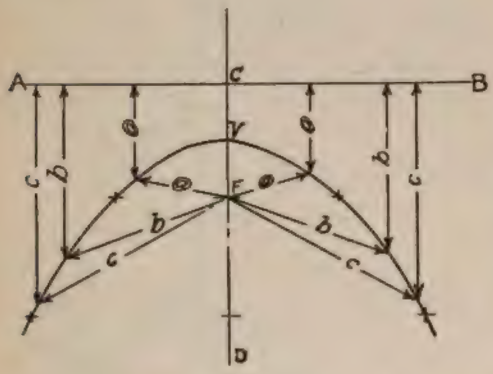
To illustrate this make CF one inch long; then CV and VF will be one-half inch each, and then take the scale and compass and swing arcs out to right and left of V with ⅝″ radius, using F as a center, and measure down from C a distance equal to ⅝″ on CD. Project this point across onto these arcs; this will give points on the arcs ⅝″ from AB.

Take ¾″ length next and so on with 1″ and 1⅛″, etc. Distances a, b, c will illustrate this, too. Through these points thus obtained, draw a curve with the aid of a French curve. If the curve thus genera[illegible] red about its axis a parabo[illegible] formed, and this [illegible] ight reflect[illegible] the rays.



In the case of a reflector for blue printing, the lamp should be set at the focus, and the vertex be about 4¼" from the focus.

The cross section of the reflector in the end view is a true parabola, and the part to the right and left of the lights in the side view will be the same curve, but the curve between the lamps may be omitted if desired, though to be correct the curves should be carried down until they intersect.



A lamp should be used that has little or no mechanism under it to cast a shadow.

The reflector and lamps can be arranged to be raised and lowered over the printing frame so it may be used for out-door exposure, too.

The reflector and car were laid out by Mr. Dan Wehnes, of the Cleveland Armature Works, and these illustrations made by Mr. Edward Sauer.

A Metal Straight Edge.

A STRAIGHT edge to aid in trimming small sheets may be made of galvanized iron in cross section like a /\, which gives stiffness.

The lower points are placed on the paper and the knife is run along the edge.

In the Engineering Record of Nov. 26 there is a description with illustration of a variable speed motor.

The Engineering Record for November 19 gives us a description of the most powerful locomotive in the world, an electric locomotive for use on the N. Y. C. & H. R. R. R. in New York City. Some interesting tests were made showing the great value of this machine, indicating a large use of this same class of locomotives in the near future.

The Engineering News of November 10 has an article of value in the design of coal bunkers and storage bins for soft coal. It discusses the dangers attendant on storing large quantities of soft coal, and gives some limiting dimensions for piles or bins of coal, with suggestions for design.

FRENCH IDEAS ON THE PRESERVATION OF TUBES, ETC.—The French Marine Department have issued orders that tubular boilers when not in use are to be filled with water to which is added a small quantity of lime or soda and those parts which are inaccessible to the application of the brush, coal tar must be burned under them, the smoke condenses on the cold iron and protects the metal. The external parts that are to be painted are given a coat of red lead.

The U. S. Civil Service Commission will hold examinations Feb. 23 and 24 for the positions of civil engineer at $2,250 per year, and for teacher in the Indian service at from $540 to $600 per year. Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., for Application Form 1312. No application will be accepted unless properly executed and filed with the commission at Washington.

A Few Hints on Drawing for Reproduction.

THOUSANDS of architects, in spite of their experience and fame, are completely in the dark as to the proper way to prepare a drawing for reproduction in a newspaper. Once in a while they may by accident produce a good reproduction, but in the greater number of drawings the engraver or the staff artist has to go over the work and reinforce it in many places. The combination of white paper and India ink is not the only thing necessary. Each line must stand out by itself, and scratchy effects entirely avoided. Make your lines firm and bold and the amateurish look can be avoided. In drawing for reproduction the original should be about three times as large as the size of the cut intended.

There are scores of other hints which might be given, but these are the most important ones. To those who wondered why drawings and plans of theirs sent to newspapers failed to appear, these few words will be sufficient.

BOOK REVIEWS.

SUCTION GAS. By Oswald H. Haenssger. Size 4½x7, 86 pages, illustrated. Cloth bound. Price, $1.00. The Gas Engine Publishing Co., Cincinnati, O.

This work is published with a view of supplying the demand for information on suction gas producers.

Owing to the economies necessarily practised in Europe where nature has not furnished a supply of liquid or gaseous fuel for internal combustion engines, the production of industrial gas from coal or other fuels has advanced considerably more than in America. Consequently it is not surprising that the suction gas producer has developed more rapidly than in America, where nature has been more generous in her supply of coal and gas.

Notwithstanding the abundance of supply in America, the European systems have become very interesting, and designers are endeavoring to investigate further.

This book then supplies a nucleus on which to build up a knowledge of this subject, and the illustrations give a clear idea of apparatus for producing suction gas.

A description of a suction gas motor is also given, with suggestions as to the care and operation of many parts of the plant, and the work closing with some chemical properties of suction gas.

Sign Writing and Drawing.

It is assumed that the office man has at least occasional use for a knowledge of lettering; and may be interested in the book at hand from Excelsior Publishing House, of New York, entitled "Practical Sign Writing." It is not a new work, else it would not be sold at such a low price; yet it deals with principles, is liberally illustrated, and contains an outline history of our alphabet. The subject of glass embossing is likewise taken up quite fully.

The same company issues a volume in stiff covers instructing "How to Draw and Paint." The principles of light and shade, of perspective, of blending colors for harmony and for contrast—these are all treated and amply explained in this inexpensive book of 154 pages. Half the contents consists of text and half of illustrations, examples referred to in the instructions given.

Practical Sign Writing and Glass Embossing.—Size, 7x5 inches; paper; 192 pages; price, 75c.; published by Excelsior Publishing House.

How to Draw and Paint.—Size, 7 1-2 x5 inches; stiff board binding; 154

panes; price, 50c.; published by Excelsior Publishing House, New York City.

Messrs. Spon & Chamberlain, 123-D Liberty St., N. Y., have just ready a most exhaustive work on centrifugal fans by J. H. Kineally, who is one of the greatest authorities in this country on the subject. This work represents the experience of a number of years devoted to this special branch of engineering, and is full of valuable data, formulas and tables compiled by the author from actual practice. The publishers are sending out free an eight-page circular describing the book to all who are interested.

Reviews for Busy Readers.

In the list list of positions applicants for which shall take the Civil Service examination, we note the position of Paleontologic Draftsman, salary $840 a year. His work will be to draw illustrations of fossils, etc.

The Engineering Record of Oct. 29 has a good article on the opening of the the New York Subway, giving briefly a history of the undertaking and giving great credit to Chief Engineer Parsons. A noteworthy fact in this connection is that there has not been a breath of scandal throughout the entire work, and it has been kept out of politics completely.

The Engineering Magazine for November has for its first article "The Building of a Chinese Railway, showing the practical work of construction by one who was in charge of the work. An illustration of a native Chinese arch, a stone bridge with two arch spans, shows that the Chinese have for centuries known the principles of the arch, and the bridge appears quite modern in all its features.

The Engineering Record for Nov. 12, has a timely article on "The Chief Engineer." Too many draftsmen getting the detail drawings for engineering construction, get the notion that they are IT and forget the head who has engineered the whole proposition and gotten it in shape to turn over to the drawing room to be detailed.

The Engineering News in its issues tor October 6 and November 10 have given us articles on Wind Stresses in Knee-Braced Mill Buildings with stress diagrams. We are getting some new information in these days as results of researches into the nature of stresses on roofs from wind pressures, and attention is called to necessary provision in designs for roofs and bracing.

The Engineering News for October 6 has a very interesting article on the nature of shearing stresses in support of the view that these are not a separate variety of stresses, but that tension and compression are the primary stresses, and other divisions including shear and torsion are merely involved combinations of tension and compression.

The Engineering Record of November 12 gives a good article on Electricity in the Machine Shop, showing various modes of application in up-todate shop equipment.

The Engineering Magazine has a strong feature in its "Review of the Engineering Press." The review is well indexed, and aims to give the descriptive title with short explanatory sub-heading or note of the most important articles in the current engineering press. The number of words or length of the article are given, with price shown for which the article in question can be secured from the Engineering Magazine.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Strength of Rings and Curved Beams.

By Ulrich Peters.

THE object of this article is to make a closer investigation on the strength of rings, ring sections, or curved beams, as chain rings, eye bolts, chain links, pipes and other circular or tubular constructions and devices occuring in shop and engineering practice.

Taking as first example for the further investigation the illustrated clamp, Fig. 1, which is subjected to a concentrated load at the pressure screws. In determining the dimensions for a given safe ring, it will be always safe to assume, according to many designers the ring cut at B-B in two halves and to figure each half as a beam, Fig. 2. Another reasonable suggestion that will confound many, is to assume the ring cut in line of A-A and to treat each half as a hook, Fig. 3. This method seems to be still safer.

Under the above two entire different and yet simple assumptions, i. e., considering the ring either as beam or hook; also two entirely different rings could be shaped for one and the same condition, Fig. 2 and Fig. 3. Consequently, from these resulting different designs of a ring follows, that in a solid ring subjected to a concentrated load P at A, A, will develop initial combined stress, which are bending and shearing at A, A, and bending and tension at B, B on the other hand, or when loaded as per Fig. 4 bending and compression at B,B. This will become more explicable when tracing the curvature of the elastic line, as demonstrated in the following:

According to theory of elasticity, is the radius of curvature of a previous straight beam element, subjected to bending forces

$$r = \frac{E\,I}{M} \qquad (1)$$

Herein is: E=The modulus of elasticity of the material.

Herein is: I=The moment of inertia of a beam section.

Herein is: M=The bending moment at that beam section.

As E is constant for a certain material and I has for any uniform beam section a definite value, it is evident that the radius of curvature r could become

indefinitely only when M = O. Abstractly, the elastic line of a beam will be a straight line, that is the radius of curvature $r = \infty$ only when the beam W

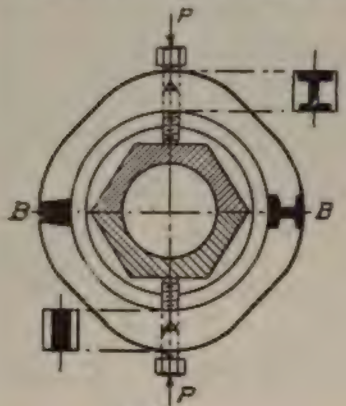


FIG. 1

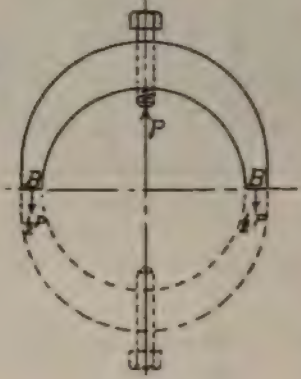


FIG. 2

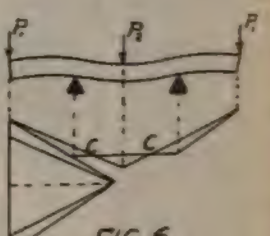


FIG. 6

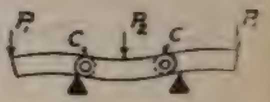


FIG. 7

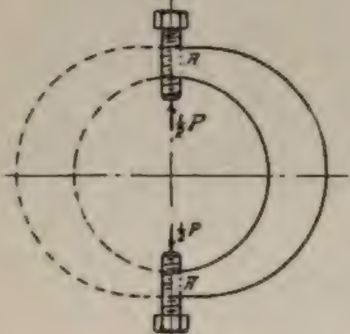


FIG. 3.

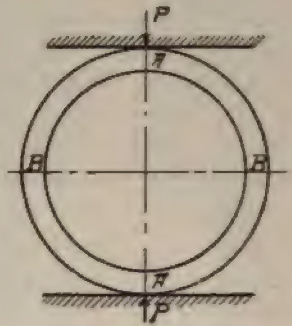


FIG. 4

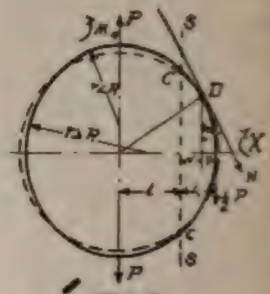


FIG. 5

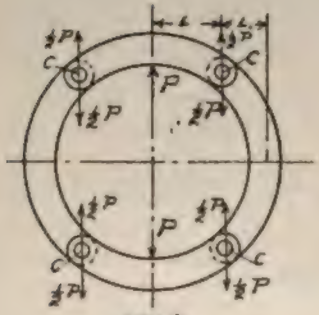


FIG. 8

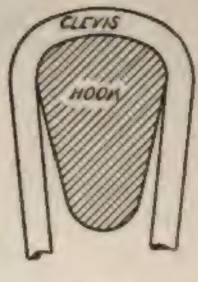


FIG. 9

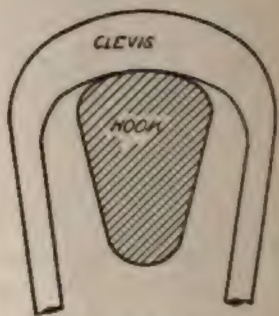


FIG. 10

Edw Sauer

thought weightless and not subjected to any outside forces like P.

Under certain consideration the same law as expressed by formula I, for straight beams, would also hold true for curved beams, such as a ring. The radius of curvature will not have then a rational value as in the case of the straight beam, but it will represent a relative value to the mean radius of a

[illegible]

... produced by P.

Each of the cross sections B, Fig. [illegible], is stressed by [illegible] and a moment X yet unknown. At any point D is originated a moment

$$M = X - [illegible]$$ (1)

and a tension

$$X - [illegible] = 0$$ (2)

This latter force X causes only an elongation in the ring and can be neglected when figuring X; we have then

[illegible]

To [illegible] the axis of the centre of gravity of arc ABA and [illegible] its distance from the ring centre and [illegible] its distance from the centre of gravity of cross section B, we so simply

$M_o = X - [illegible]$ for point B (3)

$M_o = [illegible]$ for any point D (4)

and $M_o = [illegible]$ for point A (5)

Above formulae hold true for any symmetrical shape of ring, so also for a oval, the common form of chain [illegible].

At present we consider the ring circular and it is:

$$l_1 = R\,(1 - \frac{2}{\pi}) = .364R.$$

and $$l = \frac{2}{\pi} R = .636\ R.$$

Therefore the moment at B

$$M_B = .182\ PR \qquad (8)$$

and opposite moment at A

$$M_A = .318\ PR. \qquad (9)$$

To the bending stresses from moment M_B is to be added the tensile fibre stress from ½P at b or ½Pcos ϕ at any point, respectively, substracted when load is applied as shown in Fig. 4.

A ring designed for uniform strength and lightness may assume the cross-sections such as shown in Fig. 1.

In machinery curved beams very often occur and above formulas could be used to figure and design a frame or yoke. Where there are more than two loads P acting upon the ring, the problem still remains in that part the same which has been said about the axis of the centre of gravity of the arc between two loads. After some further investigation we will find that the bending stresses become lesser, and the tensile respectively compression stresses more active with a greater number of P. And that in the case where the load is equally distributed the bending moments have entirely disappeared, as for instance in cylinders under pressure. To cause a permanent stretch or deformation in a ring eye, bolt or pipe, etc., the figured ultimate load after formula 8 respectively 9 will be much lower as practically permissible. So for instance eye bolts will stand in average cases about *twice* the figured loads.

But when crushing pipes under an hydraulic press the ultimate loads figured will be of appalling accuracy with the load reduced from the pressure gauge. In average cases eye bolts will stand about twice the figured loads.

The greater strength of a ring or eye bolt, can be accounted for the practical impossibility to apply a load concentrated at a point, as assumed in above investigation. Further, that in stretching out a ring the leverages l and l_1 become lesser. On the other hand, in crushing a pipe Fig. 4, the contact surface is increasing for the first in about the same ratio as l and l. To the importance of the shape of contact the not unknown fact may be cited, that a clevis fitted and tested for the main hook Fig. 9, often will not stand the capacity of an auxiliary hook, where the load is concentrated as per Fig. 10.

Laying Out a Rain Shed on an Inclined Roof.

BY W. M. A. COOK.

This problem is a rain shed on an inclined roof, round at the top and square at the bottom. Fig. 1 is a side elevation of rain shed. First draw the line DB, giving the angle of the roof. Then draw the stack to the size desired. Draw AC at the point where the rain shed will strike the stack. Make the points D and B equidistant from the center line of the stack. Join C and A to D and B.

Fig. 2 shows half of the plan view, making the distance EG one-half the width at bottom. The lines GE and HF are found by projecting up from the points B and D. Draw the half circle as shown, and divide it in nine parts, and number them as shown. Now draw your lines from E to 1, 2, 3, 4 and 5.

and from F to 5, 6, 7, 8 and 9. Now, going to Fig. 3, we draw the line IK and at I draw a line at right angles to

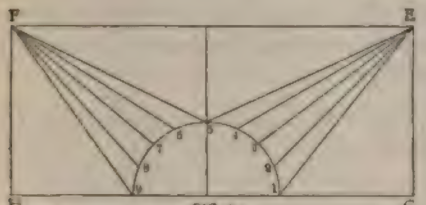


FIG. 2

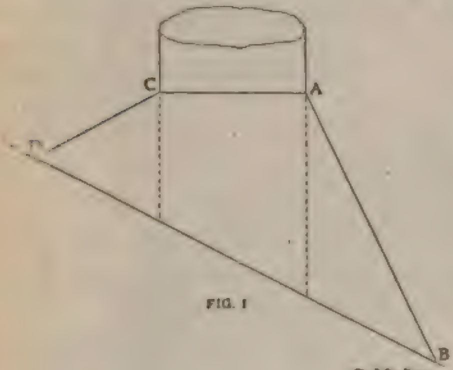
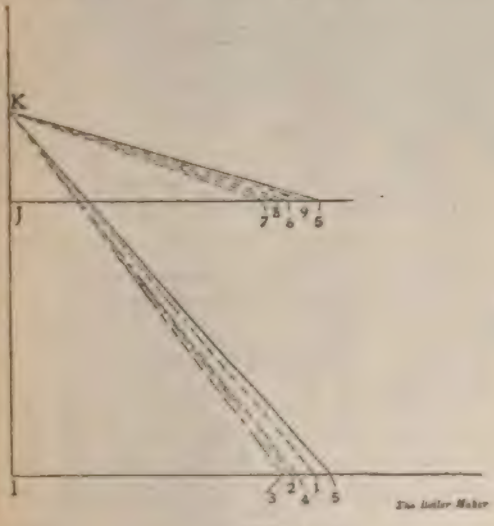


FIG. 1

The Boiler Maker

IK. Make the distance IK equal to the vertical height of the rain shed in front (Fig. 1), and make JK equal to the



The Boiler Maker

FIG. 3

vertical height of the rain shed at the back. At J also draw a line at right angles to line IK. Now go to Fig. 2 with your dividers and set it to the distance E1, lay out on Fig. 3 from I to 1 and so on until you have the numbers from 1 to 5 down, then take the distances from F to 5, 6, 7, 8 and 9 (Fig. 2) and lay them out as J5, J6, J7, J8 and J9 (Fig. 3).

We now connect K with the points 1, 2, 3, 4 and 5 on line I and with the points 5, 6, 7, 8 and 9 on line J.

In laying out, first get the length from A to B in Fig. 1 and put it in Fig. 4, as

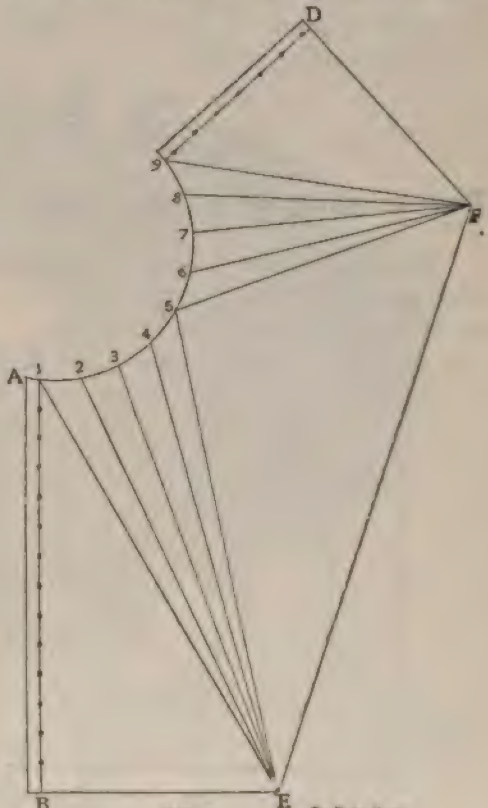


FIG. 4

The Boiler Maker

shown. At B draw the line BE perpendicular to BA and make BE equal to the distance GE (Fig. 2). Now, with your dividers, take the distance K1 (Fig 3) and lay it out from E (Fig. 4) to 1 on line A1. With your dividers take the distance 12 in Fig. 2 and lay out the distance 12 in Fig. 4. As before, take the distance K2 (Fig. 3) and lay it out as

E2 (Fig. 4). Continue this process up to No. 5.

Take the distance BD in Fig. 1 and mark it in Fig. 4 from E to F. Then as before, set your dividers from K to 5, 6, 7, 8 and 9 in Fig. 3, and place them in Fig. 4. We now want the length on the back. Take the length CD (Fig. 1) and lay it out in Fig. 4 as D9 and lay out HF in Fig. 2, lay it out as from F as FD, Fig. 4. This lays out half of the rain shed, and the other can readily be found by turning it over on another sheet and marking it off.

"The Boiler Maker."

The Drawing of a Foot Stool.

The interest in the drawing of the foot stool lies in a few facts that will be pointed out as we proceed.

It is well arranged on the sheet, the views are not crowded and no more are shown that needed.

The projection lines are not run into the object as so often occurs.

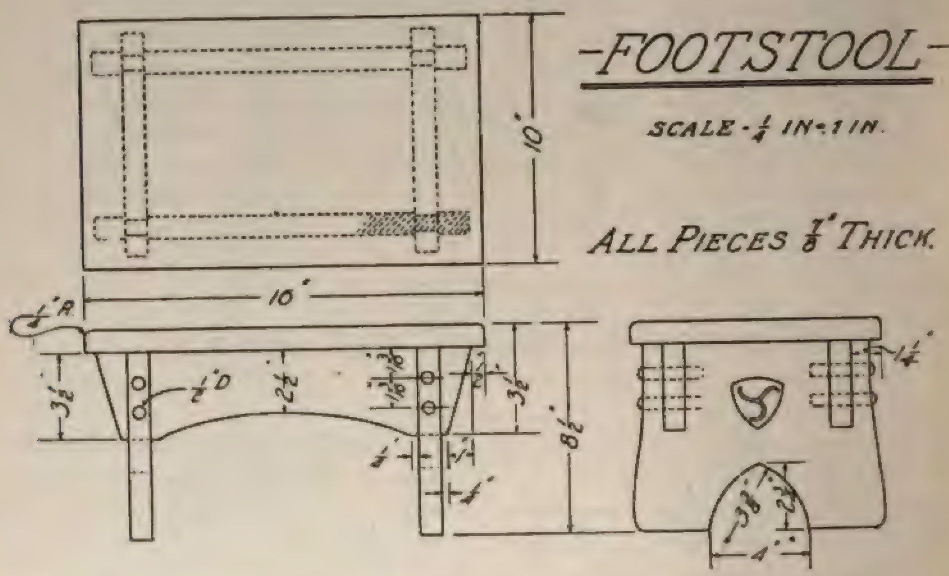
Some may say that that is a little thing but it often shows the character of the man, there is a right and a wrong way to do things and since these lines are not a part of the object they should not touch.

Notice how many drawings you have where the projection lines touch the views of the object and see if they do not appear as if all the territory between the views belonged to the views.

It is not necessary to shade portions in any view which are as well shown as the parts in the top view, really, shading of that kind is a waste of time and out of place in a well-defined drawing.

Then, too, the lines of the object are full and distinct and heavier than the projection and dimension lines.

In the end view small circles are shown at the centers of radii for the curves of the opening in the legs.



This is a good thing to do especially if the drawing is to be traced.

These comments may be adopted by some of the older readers, too.

Tangential Water Wheels.

A great deal has been done in the past twenty-five years to increase the efficiency of nozzles with the idea of using the streams for fire and power purposes.

To meet the demand for tangential water wheels, a class has been developed that show highest economy, close regulation and reliability of service.

The nozzle to control the flow of water to the wheels is of a special design, this matter having been investigated for some years by The Abner Doble Co., of San Francisco, Cal., and resulting in their particular style of nozzles and wheels.

The characteristic features of the "Doble" nozzle are the tip and the needle regulator within it. The tip, which is of brass, has a carefully ground and polished inner surface and is screwed on to the casting. The needle is also of brass, highly polished and having the shape of a plumb-bob, such as is used on an engineer's transit.

It is attached to a steel spindle extending back within the upper fork of the casting, this spindle being controlled by a screw and hand wheel.

Tangential water wheels as used in a great many places for electric power generation under high velocities of water and the design of the parts must be carefully considered.

All wheels of this firm are provided with their well-known ellipsoidal buckets, made in cast iron, semi-steel, gun metal or steel casting as desired.

Each bucket straddles the rim of the wheel and is machined to fit both sides and periphery.

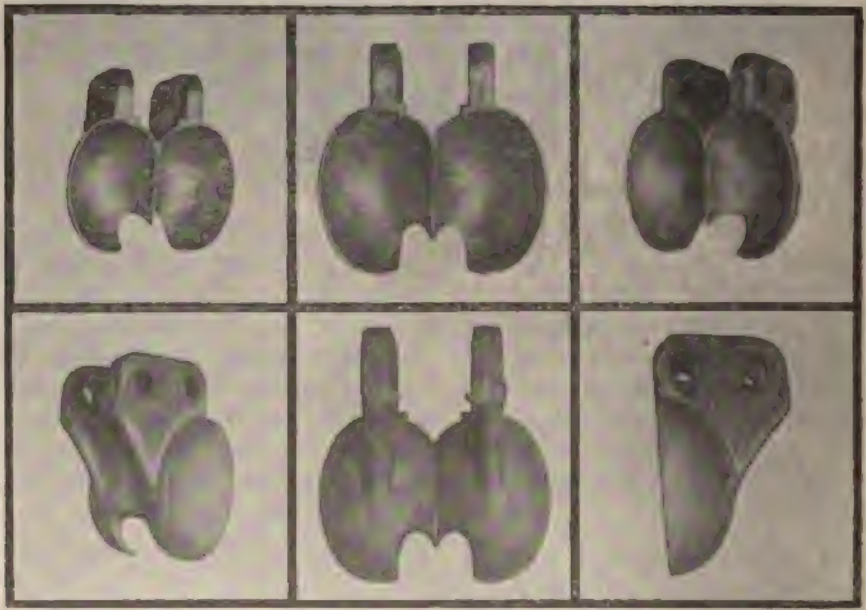
The bucket shown in the illustration was in service 586 twenty-four hour days under 1300 feet head (564.2 lbs. pressure). They seem to have worn evenly though it is said that the water carried much detrities. The next illustration shows one of the largest and most powerful wheels, built and run under a head of 1,560 feet and driving 2,000 K. W. generators at the Labla Power House of the California Gas and Electric Co. The wheel body is a nickel steel forging 10 feet 5 inches in diameter, and is bolted to the flanged end of the nickel steel hol-

low forged generator shaft.

The buckets are of open-hearth steel, designed for a jet of water 4½" in diam-

eter.

An 8,000 H. P. unit has been placed at this same power house having a turn-



ing speed of 400 R. P. M. and driven by a six inch jet of water.

The shaft for this wheel is from a hollow nickel steel forging, oil tempered and annealed 20 inches in diameter for the field hub and 16 inches in the bearings.

The bearings were specially designed and carry this revolving mass very successfully.

The next illustration shows a small

[illegible] for laboratory purposes, provided [illegible] regulating [illegible] for hand [illegible], the housing being provided with [illegible] glass sides.

The regulation of some of these water [illegible] are arranged to be operated by [illegible] rope from some distant point.

The exhibit of this company at St. [illegible] Exposition consisted of a [illegible] H. P. [illegible] water wheel operating at [illegible] R. P. M. under an effective head of [illegible] ft. and driving a [illegible] K. W. electric [illegible].

This exhibit was awarded the Grand [illegible], which was the only Grand Prize [illegible] to a manufacturer west of St. [illegible].

Apprentice Draftsman.

The United States Civil Service Commission, Washington, D. C., announces an examination on March [illegible], 19[illegible], to fill a vacancy in the position of apprentice draftsman (male), at $[illegible] per annum, in the office of the Chief of Ordnance, Washington, D. C., and vacancies as they may occur in any branch of the service requiring similar qualifications.

Can You Read It?

A writer in *[illegible] Monthly* sent in a drawing as shown in the illustration. Can you read it? Perhaps by holding

the sheet on a slant you may be able to do so. Try it.

ARCHITECTURAL.

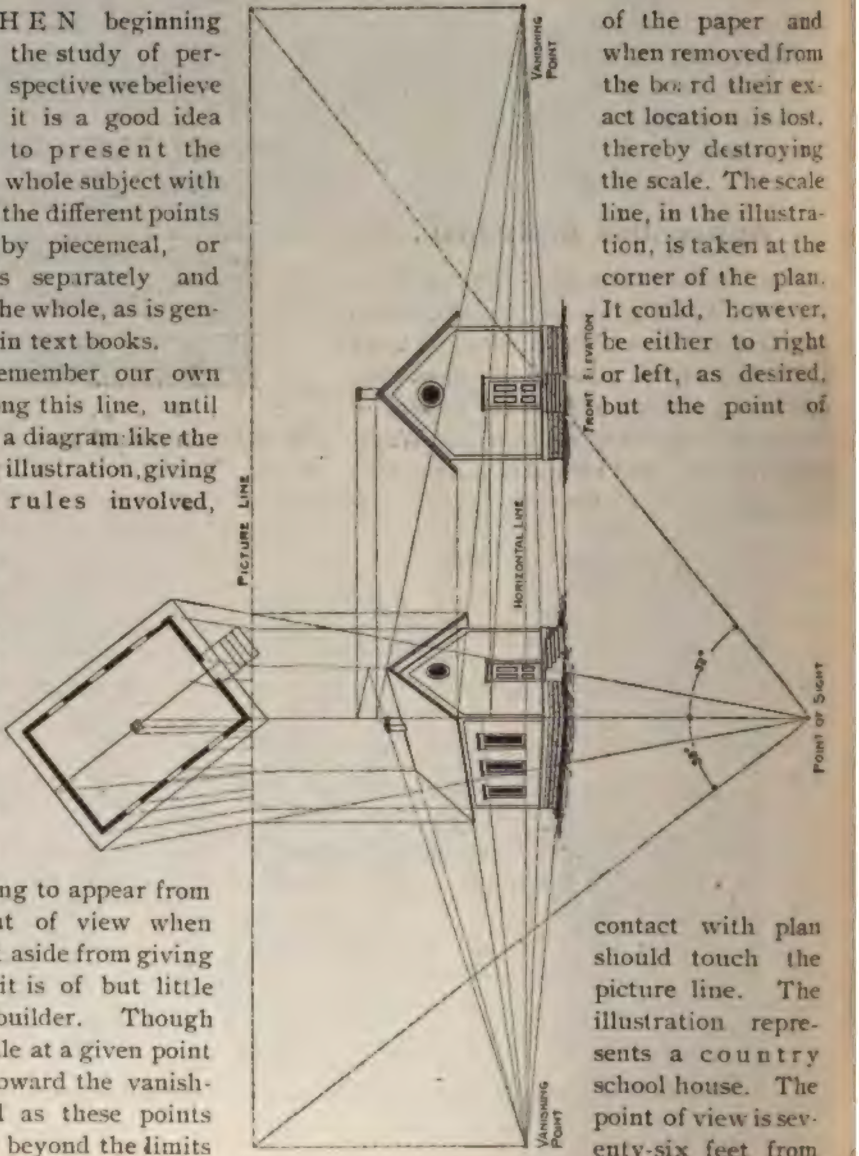
Perspective Drawing.

By A. W. WOODS.

WHEN beginning the study of perspective we believe it is a good idea to present the whole subject with the location of the different points rather than by piecemeal, or showing parts separately and then uniting the whole, as is generally taught in text books.

We will remember our own experience along this line, until we run across a diagram like the accompanying illustration, giving the principal rules involved, which was largely self explanatory without going into a lot of technical detail.

A perspective drawing shows in advance how a building is going to appear from a certain point of view when completed; but aside from giving a general idea it is of but little use to the builder. Though drawn to a scale at a given point it diminishes toward the vanishing points and as these points are necessarily beyond the limits of the paper and when removed from the board their exact location is lost, thereby destroying the scale. The scale line, in the illustration, is taken at the corner of the plan. It could, however, be either to right or left, as desired, but the point of contact with plan should touch the picture line. The illustration represents a country school house. The point of view is seventy-six feet from



the corner of the building and at an angle of fifty-two degrees and thirty-eight degrees from the scale line.

We select the above point of sight in order to condense the work, but for a pleasing effect it should be at a distance equal to four or five times the height of the building.

The outer lines from the point of sight fo the picture line are always paralleled to the sides of the floor plan whether the building is square or not and the lines of the floor plan radiate to the point of sight till they intersect the picture line and from there they are plumb. In this we have only shown the principal lines.

The horizontal line can be anywhere below the picture line and the building adjusted to it as best suits the taste of the draftsman. In this case we show the building on level ground and the horizontal would than be on a level with the eye or about five feet above grade as shown in the drawing, and is the only straight line running through the building.

A little practice will enable the learner to select the best view to take for his subject. —*National Builder.*

Interior Girders.

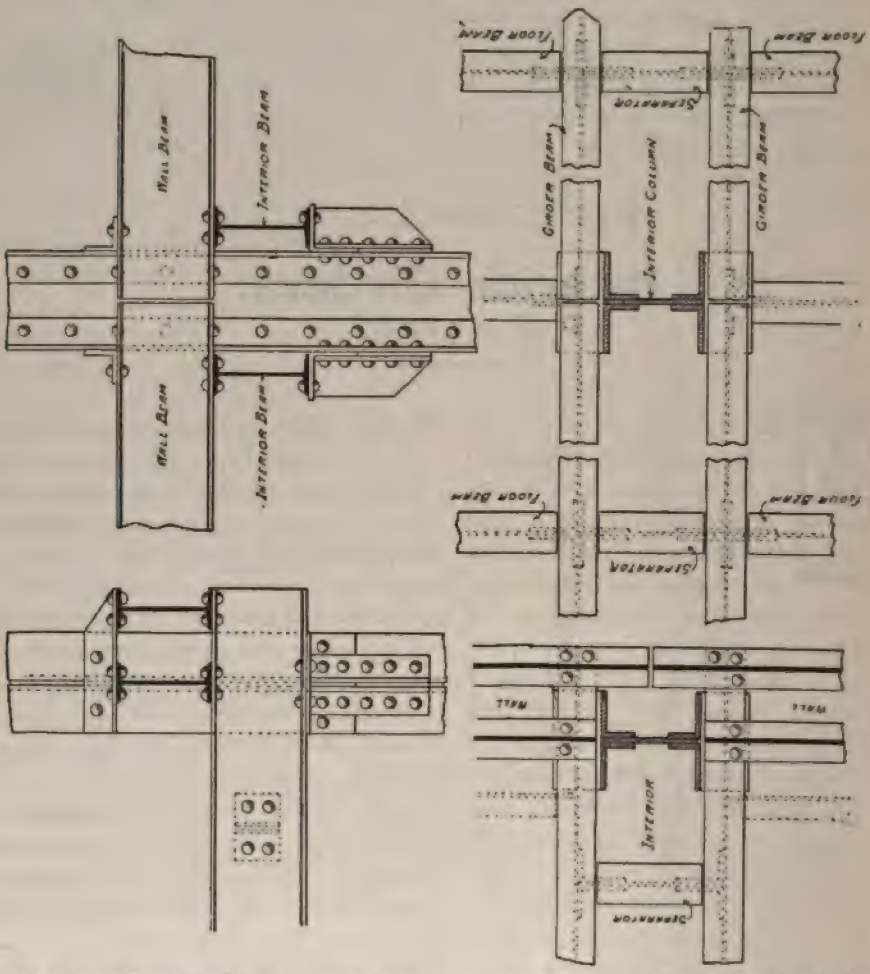
BY W. I. PARRY.

THE interior girders in an office building of the skeleton or cage type really play or should play a more important rale than the mere carrying of the floor beams, Based upon the general assumption of the theory of wind bracing that the building is to be considered as a cantliev r girder placed on end, it is evident that this bracing will require horizontal struts as well as the vertical struts or columns of the building. Whether these are considered as performing a duty similar that of the posts in a truss, or simply as horizontal columns, the necessity of their consideration in relation to horizontal pressure from wind or other agencies seems evident. In their design, therefore, the strut consideration should not be forgotten.

One way of producing the strut or column effect is the use of girders of as great a depth as the architectural requirements will permit. This may be brought about either by using deep beams or built-up girders. Another way is the development of the strut along column lines—that is, the use of a double beam or double channel construction. Where this type can be used an advantage can often be secured in maintaining the same depth of girder as that of the floor beam, thus eliminating all projections below the general ceiling line and admitting of a flush ceiling throughout. By this means is avoided the production of arbitrary lines to govern the location of partitions between rooms. It permits the interchangeability or subdivision of rooms with partition walls at any desired point, based, of course, upon the assumption that the floors would be designed, as they usually are, sufficiently strong to support these partitions at any point in the floor construction.

The objection to the use of the close double beam girder is the difficulty of handling the floor beams and girders in erection where these beams frame into

the girder. It will be readily understood that the riveting or bolting of the connections for these beams to the girders is of necessity attended with considerable difficulty, which is also encountered in setting them in place. To overcome this it has of late been the practice of some structural engineers to separate the double beam or double channel sufficiently for the easy handling of connections for the floor beams in erection, using as separators short pieces of beams at the ordinary interval of three to five feet. In some cases this method has been used, abutting the ends, where possible, against columns or else against a side plate riveted to the face of the column. This is doubtless advantageous in some constructions. Another apparently practical arrangement has been used in several cases, notably in the St. Paul building in New York City, where the interior double beam girder has been separated sufficiently to permit the use of a beam or channel on each side of, or straddling, and extending beyond the column, the projecting ends to be utilized as a bracket for the support of the outside wall or spandrel beam.



This construction has sometimes been used in high buildings with channels riveted to gusset plates, which are in turn fastened to the sides of the column. In this way the gusset plate type of wind

[illegible]

[illegible] of the column [illegible] on each side [illegible]

[illegible] The building [illegible] of the column [illegible]

[illegible] will readily be seen that [illegible]

[illegible]

[illegible]

[illegible] It will readily be seen from the [illegible]

[illegible]

This construction [illegible]

[illegible]

Architects' Drawing

[illegible]

apart from their end, which is the erection of a building. The building is the end. This is what the owner invites the architect to produce for him, and its production is what he pays the architect for. One stage in the production of a building is the estimation of its cost. For this, if the owner pays a fee, he gets in return the knowledge which he wants and which is therefore of value to him. What further values does he get by having the drawings handed over to him? None whatever, unless he means to use them to produce a house. It is the client's right to use the drawings, which is granted when he is given possession of them. This is the implication, and in the implication is implied a recognition of the true nature of an architect's drawings—that they are but means to the production of a building. But has the client a right to use an architect's drawing apart from the architect and against the wishes of the architect? Is the law then to be invoked to enable clients to cheat their architects; to enable anyone, who has once deceived an architect into making drawings for the purpose of erecting a house, to bone the drawings and walk off with them, under the protection of the police?

The vexed question of who owns an architect's drawings is about to be settled for Englishmen, says the Canadian Architect, by an appeal from the decision in the case of Gibbon vs. Pease. This suit by a client, for the possession of the drawings upon the conclusion of the work, was decided in favor of the client, Gibbon. The weak point in the case, on the side of architects, is the custom, acquiesced in apparently by the profession, that, when a building is not carried out, the drawings should be given up, in order that the client may have something for his money. The client has, as a matter of fact, got something for his money. He has got accurate knowledge of how much it would cost him to build. If it is this knowledge which causes him to desist from his purpose, its value to him is measured by the extent to which he saves himself from embarrassment by so desisting. He has probably got the worth of his money.—*So. Architect and Building News.*

Making Architectural Drawings.

To the beginner, in architectural drawing, as in all others, there appears a "boo-boo man" in the shape of lack of knowledge as to sizes of various objects.

These objects are so common and in such near relation to our everyday life that it is not hard to realize their shapes from the names given.

No one, we might say, does not know what a door or window is, and there is a large number of objects that are not so common, but which are easily understood.

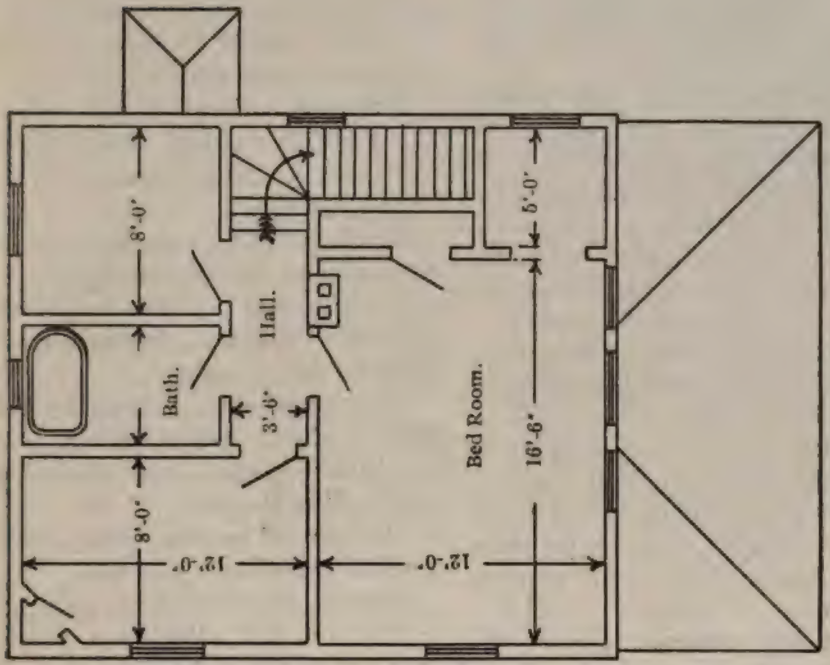
Let is be required to lay out the arrangements of rooms in a two-story house, each sketch or drawing being called a "plan" and usually labled FIRST FLOOR, SECOND FLOOR, etc., etc.

The illustration here given shows three rooms and a hall down stairs, and three rooms and a bath upstairs, the building being what is understood as a frame dwelling.

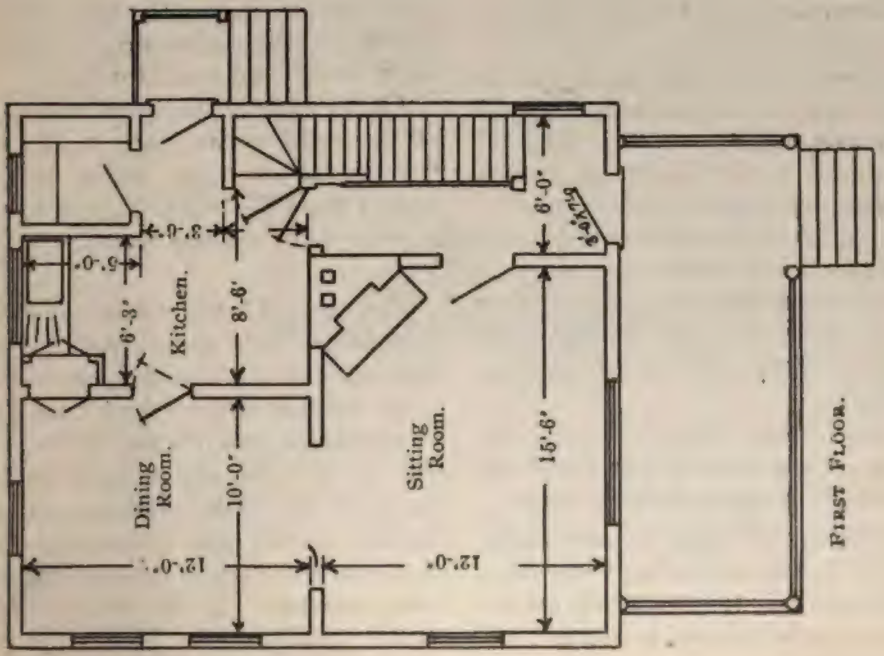
It might be well to state that architectural drawings are drawn to scale; that is, not full size, but to a size usually ¼" to the foot, though in some cases ⅛" to the foot is used.

In laying out a plan it is necessary to know the sizes used, so to get all parts in proportion, and by a little observation on the part of the draftsman many dimensions may be found to aid in the work. It might be a good idea to jot

Illustrating the Making of Architectural Drawings.



SECOND FLOOR.



FIRST FLOOR.

these down as you measure them, and thus have them for ready refrence.

The following will be divided under headings of the parts or objects as they are needed in the production of the drawing:

WALLS.—These, for a frame house, consist of studding, 4" wide, the sheathing and weather-boards, or clap-boards, the lath and plaster. (No allowance being made for the paper.)

Altogether they measure about 6" and are so considered so that the outer and inner lines are thus made 6" apart.

The partition walls are made of studding, 4" wide, two lots of lath and plaster, about 5" altogether, and so drawn.

The distance between walls should be made a convenient figure, in even feet or half feet, as shown, and the size of rooms as large as possible, though the ones shown are a trifle small in some parts of the house.

Where a wall projects to a door, this should not be less than 6".

ROOMS.—These should be arranged to be as convenient as possible, not so one room must be crossed in an awkward way to enter another.

Since carpet and matting is sold in 3-foot widths, a room should be 9, 10½ or 12 feet wide, etc., so as to allow these articles to cut to best advantage, though sometimes this is hard to accomplish.

The placing of furniture should be arranged to a certain extent, too, and some thought given to the natural light. Space allowed along the walls for beds and dressers, and the windows arranged accordingly.

DOORS.—These should be large, the opening on the drawing just shows the actual width of the body of the door.

The size and thickness is often noted, as shown in the case of the front door, which is generally larger than the others.

Doors may be obtained in widths 2'-0", 2'-6", 2'-8", 2'-10", 3'-10" and 3'-6", and in lengths 6'-0", 6'-6", 7'-0", etc.

For inside doors, a 2'-6" width by 7'-0" length is generally used, while the front door should be about 3'-0" wide, and closet doors 2'-0".

The door is shown open a trifle, this line being drawn with the 30 deg. triangle and of a length equal to the width of the opening.

Doors should be arranged to swing back against the wall, to be out of the way when open, and also be located so that large pieces of furniture may be carried through easily.

Occasionally a door will have to be located so that it swings against another, but it is generally a case where one is shut most of the time.

The step of outside doors is shown extended outside the wall line.

Openings for double doors are generally 5'-0" or 6'-0", though a narrower opening may be made in some cases for a single wide door. These openings may be finished and no doors shown, the space closed with curtains. The door between kitchen and dining-room may be a double swing one, shown with two lines.

It is not necessary to put in arcs, showing the swing of the doors, in all cases.

Transoms over the doors may be marked thus, T—10"x2'-6", and written in one side of the line representing the door.

WINDOWS.—These are shown by means of a pair of light lines, parallel to the wall lines and terminated by cross lines.

The distance between these cross lines is equal to the sash, the size of the glass often being given; this is the width and length of the "light" (pane), and the character of the glass is determined by the description given in the specifications. Large windows may be marked *d. s.* (double strength), in addition to the

size.

The window in the kitchen should be large, at least 4'-0" wide, while the majority of the others need not be more than 2'-6" between cross lines.

STAIRS.—These are like the ordinary ones, usually 3'-0" to 3'-6" wide, with lines of steps 8" apart.

The stairs should start at least 4'-0" from the front wall and be calculated to end in a convenient place.

In this case there are 19 steps at 8" each, or 12'-8" from first floor to top of second floor, and deducting 12" for thickness of ceiling, would make the rooms 11'-8" high, which is excessive.

It would be better to cut out the three corner steps and calculate the distance from top of one floor to top of other to be 10 feet.

The location of stairs and the beginning and ending shall be carefully considered in both plans.

The top step should be at least 6" from the edge of the door opening in the second floor plan.

When corner steps are necessary, they are drawn with the 30-60 deg. triangle.

CHIMNEYS.—These are usually built of brick and have openings 6" to 8" square, with 4" brick around them.

One flue for the grate and one for the kitchen will be necessary.

KITCHEN SINK.—A kitchen sink should be at least 18"x26" in the bowl and have a drain board 21" wide and 24" long if possible, and there should be a drain board at each end, if space in the kitchen does not permit the use of a table.

BATH ROOM.—The tub, seat and bowl are shown in the accompanying sketches, the space around the tub should be about 3" and the objects arranged to permit the door to open wide.

PORCHES—The front porch should be at least 8' 0" wide and extend to within 12" of the sides of the house with the steps 5 feet long.

The side porch or "stoop" is about 4' 0" square.

MISCELLANEOUS — Cupboard shelves are 12" to 14" wide. China closets should be fitted with two sets of doors, so that articles may be passed through from kitchen to dining room.

HOME STUDY.

Mechanical Designs.

CHAPTER VII.

Bearings.

BEARING is the general name given to the support of a moving machinery part. When the moving part is round, it is called a journal and its bearing is sometimes called a journal box.

All bearings wear more or less rapidly and therefore have to be adjusted to take up such wear.

The adjustment is made by means of brass or composition liners, which are split and can be moved in the direction of the line of the pressure, so as to preserve the shape of the bearing, or be easily moved when worn out.

In Chapter V, a method was shown of adjusting bearings by means of a jib and key. Another method is by using a movable cap with bolts, as illustrated by this plate. Journal boxes are sometimes bored out a little larger than the shaft and then run with melted babbitt. This form of box can be taken down when worn and rebabbitted.

Sliding bearings, such as are used on the ways of lathes and planers are discussed in Chapter VI, of Benjamin's Notes on Machine Design.

All classes of bearings are designed on the general principle that one metal when rubbing on another will stand so many pounds pressure to the square inch of surface. This pressure depends upon the size and material of the bearing; the speed of the motion and the nature of the service.

Let $W =$ total load on journal in pounds.

$l =$ length of journal in inches.

$d =$ diameter of journal in inches.

$N =$ number of revolutions per minute.

$V =$ velocity of rubbing in feet per minute.

$F =$ friction at surface of journal in pounds.

$F = W \tan \Phi$, nearly.

Tan Φ is an expression which shows the angle at which one rubbing surface will slide down when placed on another rubbing surfoce. Tan Φ will be given value here varying from .01 to .05, depending upon the kind of surface and the nature of the lubricant.

The safe pressure on journals may be taken at from 300 to 500 pounds per square inch of projected area.

If the pressure is taken too great, the oil will be squeezed out and the bearing will *seize*.

The projected area is equal to the diameter multiplied by the length of journal.

Journals should be designed large enough to prevent heating and wear and for strength and stiffness.

The proper length of a journal depends upon the liability to heat, for the friction of the journal produces heat and

if the projected area is not large enough to convey the heat away, it will keep getting hotter. Now, if the diameter is increased, the speed remaining constant, the velocity of rubbing will be increased and therefore the heat due to the friction, more rapidly than the projected area is increased. On the other hand, if the length is increased, it increases the projected area faster than it does the friction of rubbing. Therefore to prevent heating, increase the length of a journal.

The formula for a journal to prevent heating is:

$$l = \frac{W N}{C}$$

C = a constant found by experiment and may be taken at from 200,000 to 400,000.

To design a journal to prevent wear the formula is:

$$ld = \frac{W}{300}$$

When 300 is the allowable pressure in pounds per square inch.

Little can be said about the formulas for strength and stiffness, until the student is familiar with mechanics. The formulas can be used as given, however.

For strength

$$d = 1.721 \sqrt[3]{\frac{w l}{s}}$$

And for stiffness

$$d = 4 \sqrt[4]{\frac{Wl^3}{E}}$$

S = stress per square inch and may be taken at 8,000 to 12,000 pounds for steel journals.

E = modulus of elasticity = 28,000,000.

No factor of safety need be used with the formula for stiffness, and for both strength and stiffness, the maximum and not the average loads are used.

It is best to design a journal by all four of the above formulas and then take the safest results.

Questions.

1. Make a sketch of a lath bed showing a cross section of the V's.
2. Same for the planer bed.
3. How can flat slides be adjusted to take up wear?
4. Sketch a stuffing box for a steam engine.
5. A box car weighing 20 tons is designed to carry a load of 50 tons. It is supported by two trucks having four wheels each. The axle journals are of Bessemer steel and the wheels 36 inches in diameter.

Design the journals for heating, wear, strength and stiffness. Speed of train 45 miles per hour. C = 400,000. Factor of safety 10.

6. Measure the crank pin of some engine; calculate the constant and compare them with those given in this chapter.
7. Calculate the safe load on the pillow block used in this chapter, considering heating and wear.
8. Using the maximum load found in (7), calculate the pressure per square inch under the base plate and determine from tables of allowable bearing pressure on brick or wood given in the engineering hand books, whether the base plate given is large enough.

Some Odd Algebra.

In a copy of algebra used in the schools of Ireland we find one division, that on "Permutations and Combinations," which is not in most books we see on this subject.

"Each of the arrangement which can be made by taking some or all of a number of things is called a Permutation."

"Each of the groups or selections which can be made by taking some or all of a number of things is called a Combination."

"In forming combinations we are only concerned with the number of things each selection contains; whereas, in forming permutations we have to consider the order of the things which make up each arrangement; for instance, if from four letters, a, b, c, d, we make selection of three, such as a b c, this single combination admits of being arranged in the following ways:

abc, acb, bca, bac, cab, cba,

and so gives rise to six different permutations."

"Example: Four persons enter a railway car in which there are six seats, in how many ways can they take their places?"

"The first person may seat himself in six ways; and the second in five; the third in four, and the fourth in three; and since each of these ways may be associated with each of the others, the required answer is 6x5x4x300=360."

"Another: "A railway carriage will accommodate five persons each side; in how many can ten persons take their seats when two decline to face the engine and a third cannot travel backwards?"

Another: "Out of the 26 letters of the alphabet in how many ways can a word be made consisting of five different letters, two of which must be a and e?"

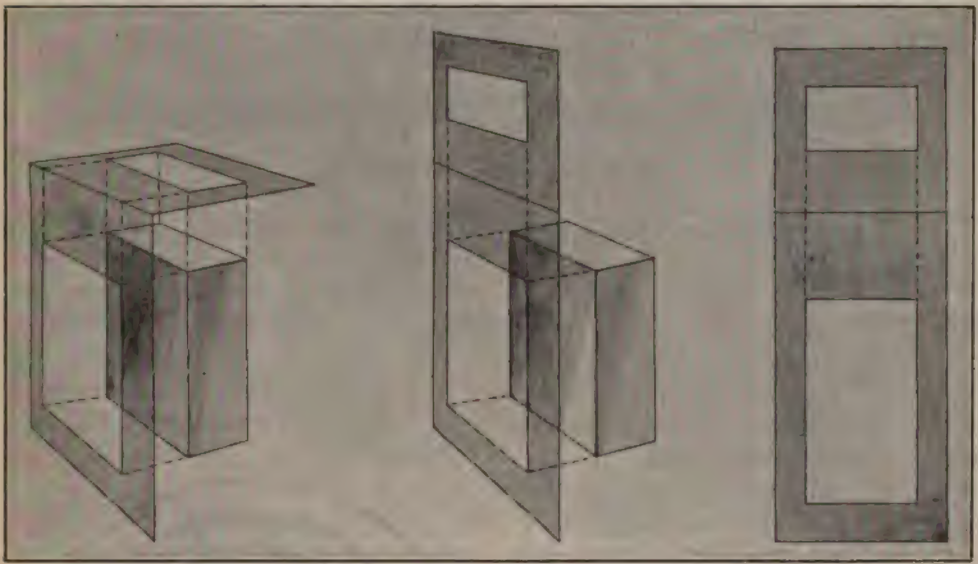
An endless variety of problems may be made up in this manner and the book gives a great many.

Orthographic Projection.

BY PROF. A. EDWARD RHODES.

THERE are many ways of illustrating how the several views of an object may be obtained. Perhaps the best device for this purpose is to fold a piece of transparent paper to a right angle, then hold it over the object so that one-half of the paper is vertical and the other half is in a horizontal position. We then speak of the horizontal part of the paper as the horizontal plane of projection, and the vertical part as the vertical plane of projection. Imagine now that you are looking directly down through the horizontal plane of projection (in Fig. 1). Mark on the horizontal plane of projection the four corners that you see on the object; connect these corners and you have the top view or plan of the object. Now change your position and look through the vertical plane of projection, mark on the vertical plane of projection the position of the four corners you see, connect them and you have the front view or elevation of the block. Figure 2 shows the horizontal plane of projection unfolded and Fig. 3 shows the two planes, and drawing as they actually appear on the drawing board. Notice that the top view is directly above the front view, that the top view is as far above the ground line (meeting edge, or folding line of the two planes) as the block is back of the vertical plane of projection; also that the front view is as much

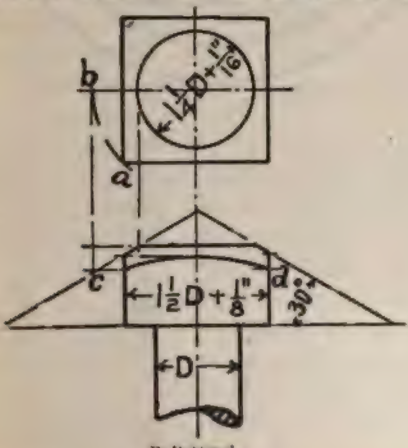
below the ground line as the block is below the horizontal plane of projection. By understanding and applying the above rules of orthographic projection



the geometrical outlines (working views) of any object may be drawn, the addition of dimensions and other data being merely a matter of judgment.

To Draw the Square Bolt Head.

The surface of the chamfer is really that of a cone, which is shown by the



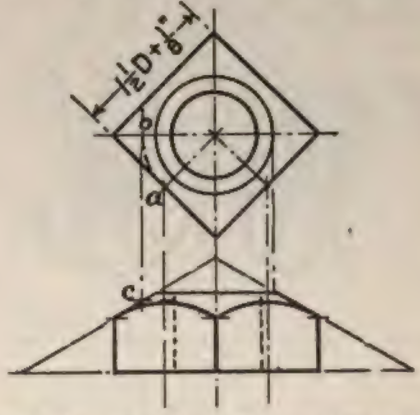
Bolt Head.

dotted line. These are at an angle of 30° or 45°, and much or little may be cut from the head; thus the circle left on the top may be tangent to the sides or as shown. Diameter of top circle may be $1\frac{1}{4}D+\frac{1}{16}"$.

A horizontal line is drawn to give the top of the curve in the front view, and the lower points can be obtained as shown. Swing *a* to *b*, project *b* to *c*, and draw *cd*. The height of head is equal to the diameter of bolt.

TO DRAW A SQUARE NUT.

A square nut is usually drawn so as to show two faces, and the amount of chamfer is taken as explained above, also the



top circle. The illustration will no doubt explain itself.

ILLUSTRATING.

An Ethical Study of Monograms.

By Charles C. Riester.

MONOGRAMS—their origin and heritage—an ethical study of their usages in primitive times, the growth from hieroglyphical writing to the present adobtion of monograms, which is essential for the connection with the individual.

Monograms are two or more letters interwoven or made so as to cling in each other. The first letter of a name made into neat initials so entwined constitutes a monogram.

With this in view I will endeavor to give the required ethical study, for which I have selected six sketches. The first being a modern script letter M. H. W., the three letters named are the broadest in the alphabet, to entwine them so as to make a neat monogram requires practical experience. You will notice by following the lines of the H. its left half

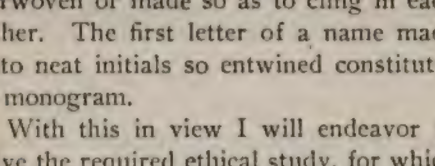


Fig. 1.

is carried across a little above the center of the M. which you perceive is natural enough, the right half follows at the bottom of the W. By itself the H. would look very odd, but with M. and W. it makes a neat monogram.

The origin of the monogram dates back into the very recesses of time memorial, when writing and letters were in the forms of rough pictures, outlined or carved on stone and wood, called hieroglyphics. When we search into the

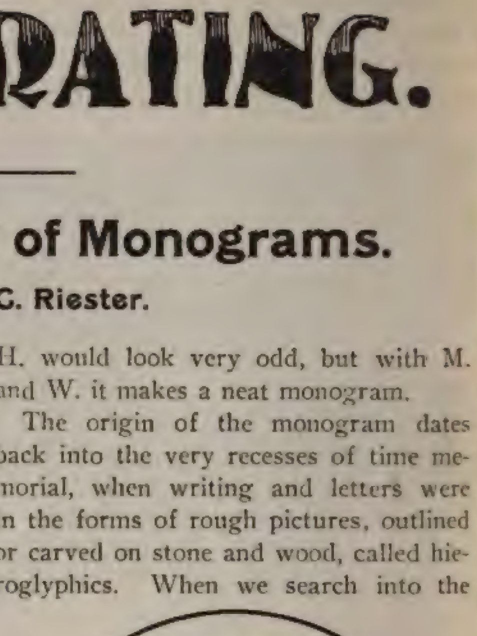


Fig. 2.

hidden past to find the origin of hieroglyphical writing it astonishes the most intellectual classes and brings them in touch with the nativity and infancy of hieroglyphical writing.

Hieroglyphics — a crude symbolic meaning of thought, made to convey a knowledge to another party without the use of guttural sounds, signs which were understood by the sentient race of the beginning of time.

Records are found with inscriptions

of hieroglyphics in ancient Egypt and China as far back as 3600 years B. C. These marks or pictures carved on stone tablets gave the historical societies names, messages and history; by the certain hieroglyphics they could ascertain where and by what race it came from. These pictures were sometimes an individual name which connected it with his personality.

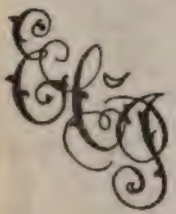


Fig. 3.

Fig. 4.

Each private individual of note had one or more of these signs which familiarized him among the Plebians they at once knew the so-called hieroglyphics and consequently this was an ancient seal or monogram.

The Egyptians 2000 years B. C. used a picture, drawing or carving and tinted them in natural colors for giving expression on walls, buildings and the sarcophagi or burial place.

Some of these species can still be seen in some archeological museums in foreign countries.

The Plebians, who beheld the heiroglyphical writings of their high priests at once recognized it and paid homage by getting down on hands and knees with meek reverence for him they considered immortal.

Consequently, this was the first impression of the value in linking certain hieroglyphical writings to their personality, which gave them prestige in popularity; hence the adoption which marked their superiority. For instance, the barbarious tribes, whose highest conception of wisdom was to assume a like greatness of their king to the sun, drew a rough circle with strokes emanating from it with a vertical spiral, which represented the name of their king.

The presumption of hieroglyphics existence may be traced to the oldest period of time. The Chinese evidently are the only contemporaries with the Egyptians, Assyrians and the Jews. Through the long struggles for supremacy between Babylonian and Persian, the triumphs of the Greeks, followed by the obsorption of what remained of the Macedonian conquests in the Empire of Rome—throughout this vast period hieroglyphical writing has been eminent. This deep research has not as yet been entertained by any historian, for whom prudence is his consort.

The few illustrations I have given in this article are variable in forms and character. No. 2 initials are W. D. B., as you perceive these are made into a circle and is the same script used in No. 1.

Monogram No. 3 is E. C. J., this design is very neat when put in the upper

Fig. 5.

left hand corner of fine stationery and will look well if printed in colors, say blue on heliotrope, red on pink, etc. No 4 and 5 are more common and show how they can be interwoven or hung

onto each other. The text letter used in No. 6 can be so worked as to appear very rich and unique when painted with bronze of gold and silver.

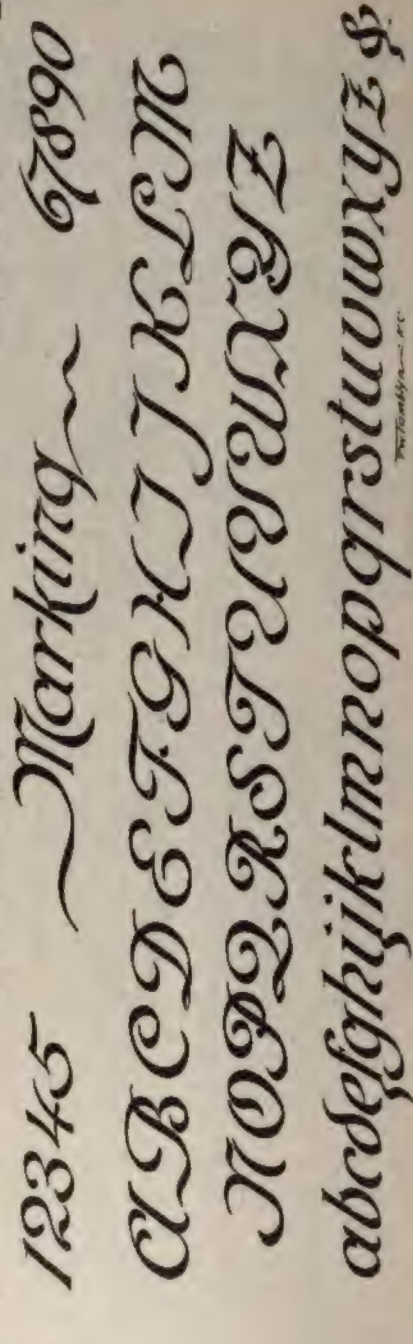
Monograms, crest and coat of arms have had a prevailing persistency in keeping astride with the universal conflicts of time, yet we in our age adhere more and more to these individual distinctions. Those who cannot boast of any heraldic device can use their initials by entwining them into a monogram.

FIG 6.

As the American Eagle is a symbol of the United States, the Lion of Great Britain, the Bear of Russia, so is a monogram a symbolic sign to corporations, merchants and the private individuals, it is the keynote to popularity. To assume a monogram is entirely appropriate and should be on all stationery used for private correspondence.

A Marking Alphabet.

(From Penman's Art Journal)



Marking Alphabet by F. W. Tamblyn, Kansas City, Mo.

CURRENT TOPICS.

Folks in Ruts.

TH' world is full o' ruts, my boy, some shaller an' some deep;
An' ev'ry rut is full o' folks, as high as they can heap.
Each one that's grovelin' in th' ditch is growlin' at his fate.
An' wishin' he had got his chance before it was too late.
They lay it all on someone else or say 'twas just their luck—
They never onct consider that 'twas caused by lack o' pluck.
But here's th' word of one that's lived clean through, from soup t' nuts:
Th' Lord don't send no derricks 'round t' hist folks out 'o ruts.

Some folks has stayed in ruts until they didn't like th' place,
Then scramble bravely to th' road an' entered in th' race.
Sich ones has always found a hand held out to them t' grab
An' cling to till they'd lost the move peculiar to a crab.
But only them that helps themselves an' tries fer better things
Will ever see th' helpin' hand t' which each climber clings.
This here's the hard, plain, solemn facks, without no ifs or buts:
Th' Lord don't send no derricks 'round t' h'ist folks out o' ruts.

—Baltimore American.

Too Many Applicants for the Panama Canal Service.

The United States Civil Service Commission is receiving thousands of inquiries concerning examinations for the Panama Canal service, and for the information of the general public it announces that the number of applicants for clerical and professional positions in that service, including clerk, bookkeeper, timekeeper, surgeon, physician, pharmacist, hospital-interne, trained nurse, assistant civil engineer, instrument man, transit man, level man, rodman, and chainman, is far in excess of the needs of the service, and it is not expected that any more examinations of this kind will be held in the near future. No more applications will be accepted for these positions at this time, and no further information will be furnished in regard to them.

Competent and experienced persons are especially desired for positions as members of steam-shovel crews, particularly crane men and pit foremen.

Sweet and Sticky.

The Engineering Record of September 17th, gives an account of a molasses pumping plant, for discharging molasses from tank steamers into tanks in warehouses.

The same paper in their issue of Nov. 26, gives a description of apparatus for pumping tar and other heavy liquids.

Mechanical Messengers.

Pneumatic Carriers for Drawings, Tracings and Packages.

In modern stores, factories and offices there are so many uses for mechanical or pneumatic carriers that a messenger service is becoming an important part of building equipment. In the Western Union building, New York, 150,000 messages are distributed daily by the Lamson pick-up carrier. From a central distributing station on the eighth floor pick-up carrier lines radiate to all parts of the operating rooms on the seventh and eighth floors, delivering messages to the hundreds of operators quickly and accurately. In banking institutions and in brokers' offices it is often the case that the bookkeeping department is separated from the tellers and cashier, and mechanical carriers are employed to convey depositors passbooks from the tellers to the bookkeepers, sometimes in other rooms. In a location where rents are high this carrier allows institutions which deal directly with the public to have a comparatively small space on the ground floor, with the clerical force located in less expensive quarters.

In a large factory office building a mechanical pick-up carrier is employed for distributing correspondence matter among 400 employes. At the works of the General Electric Company at Schenectady tracings and blue-prints are distributed and corrected in the same manner. At the vault where the drawings are kept is the terminal station of four lines of automatic carriers. These are dispatched when wanted, in a carrier four inches in diameter by three feet seven inches long, by placing the carrier on the terminal elevator corresponding with the station to which the carrier is to be sent. On arrival of the car the carrier is picked up and automatically delivered at its destination. The drawings are returned to the vault in the same manner, so that no record drawings are out of the vault any longer than necessary.

The largest pneumatic transmission plant for purposes of factory intercommunication is now being installed in the General Electric Company's works, at Schenectady, N. Y. Over four inches of $4\frac{1}{2}$-in. tubes will be used. Of course, the best known application of this system is in the retail stores where it is used for the purpose of making change.

"Municipal Record."

The United States Civil Service Commission announces an examination on May 3, 1905, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of clerk in the Departmental Service.

This examination is open to all citizens of the United States who comply with the requirements.

Only legal residents of the following-named States and Territories will be admitted to the examinations: Alabama, Arkansas, Florida, Georgia, Hawaii, Indian Territory, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Porto Rico, South Carolina, South Dakota, Tennessee, Texas, Utah, and Wisconsin.

Applicants should at once apply to the United States Civil Service Commission, Washington, D.C.

A Norwegian engineer has invented a device for making sea soundings by which it is not necessary that the bottom should be touched or even approached. The working of this apparatus depends upon the time required for sound to travel to the bottom of the sea and return, as by a rebound from a wall. It is like the aerial echo which comes back from mountains and hills.

Draftsmen's Society.

There has been from time to time suggestions made to organize a draftsman's society, with some of the following ideas included in the object and rules.

It is proposed to form the American Society of Draftsmen, to be composed of such members as hereafter stated. That there be formed in each city a society with headquarters where meetings could be held at such times as the members may decide.

That there be a connection with other branches of the national society and that men be transferred from one to the another if desired.

That each branch have a bureau of information for members coming into a city, also a reporting secretary to the general secretary, of the meetings, good talks and general conditions in that city.

These talks and lectures should be put in bulletin form or published in the pages of this magazine.

The members should be draftsmen or those directly connected with such work, as engineers and architects and tracers, and blue print boys be entered as associate members.

There should be no tendency to form a society that will curb the ambition of some able young man who has a talent for the work and yet who is not as old as some of the men.

No restriction should be placed on an application for membership as to term of years of service or as to the class of work or nationality, so long as he is a draftsman.

The meetings should be arranged to be of interest to all members and be of interest to all members and be largely technical in nature.

Some one has said that if it is to be a reporting agency like Dunn's or Bradstreet's it would suit him fine, for the other engineering societies supplied everything desired in regard to information.

They may for a few, but not for the many.

While some may wish to establish a "job hunting bureau," it would be better to leave that to the well known agencies and to devote the energies to improving the members so they can hold a better job.

Expressions are desired from members of the fraternity and all letters for publication will be given space next month.

Geologists Were Wrong.

The construction of the great Simplon tunnel has proved once more that geology is largely a matter of theories which may or may not fit actual conditions, even close to the surface of the earth. The engineers have discovered that the geologists were entirely at fault as to the temperature which would be encountered, missing the mark 25 degrees at the point where hot water was found. The water conditions in general were unlike those predicted, and the engineers found that the dips in the rock strata which had been declared, on theory, to be mainly vertical were, in fact, horizontal.

Apparatus for Locating Fish.

A patent has been taken out in Germany for apparatus whereby shoals of fish can be located when far beneath the surface of the water. It consists of a microphone, inclosed in a water-tight case, which is connected with an electric battery and telephone. The rope attached to the microphone is marked so that the exact depth of the shoal is at once ascertained. When a shoal of fish come along, the constant tapping against the case of the microphone produces sounds in the telephone which at once betray their presence.

Do you notice that more draftsmen are wanted now than at any time since 1901?

Johnny Wants to Know.

Says Johnny Jones to his instructor,
"Is a motorman a non-conductor?
An' the feller that makes
Fur-wraps, like big snakes—
Would you call him a boa-constructor?"

A New One.

"Gentlemen: I enclose two bits for the four months' subscription. Yours resp."

This was short, but it was enough to place him on the list. Two, four and six "bits" are very common expressions in some districts of our country.

A well known agency recently advertised for mechanical engineers, and the most of the replies came from stationary engineers and firemen. It would be far better if there was some term that expressed the class more adequately, such as "Ingineur".

Some engineers are draftsmen—that is, they are doing some drafting; but few draftsmen are engineers, and again we say it would be a good idea to class the men as engineers, designers, detail draftsmen, tracers, blue-printers.

It is often the case that a tracer was originally a printer, and a detailer comes up from the rank of tracer.

BOOK REVIEWS.

Ferris and Heliographic Processes.

A hand-book for photographers, draftsmen and sun printers. By Geo. E. Brown, F. I. C.; 130-page, 5½x7; Tennant & Ward, 287 Fourth avenue, New York. Price, $1.00.

This hand-book is intended to serve two classes of people. First, amateur photographers, with a taste for experiment, who find in the preparation of their own sensitive papers much interesting work; secondly, draftsmen, engineers, surveyors and others who find the reproduction of tracings and drawings a matter of every-day necessity.

The first chapter takes up the Ferro-Prussiate or blue print process, gives formulæ for preparing chemicals and methods of preparing paper. Chapter II treats of toning blue prints, giving formulae, for greenish black, brown tone, purple-brown, violet-black, lilac, black tones, and modified blue. It also gives formula for brightening and intensifying colors. Chapter III deals with the uses of blue prints, such as transparencies on glass and paper, decorative purposes, and the use of these prints in preparing newspaper illustrations, laboratory work, etc. Chapter IV, Ferro-Prussiate in tricolor work. Chapter V, the Kallitype process. Formulae are given for this and the developers for black, blue and maroon tones and the fixing solution. Chapter VI gives the Obernetter process, its formula developer, etc. Chapter VII, Uranotype process. Chapter VIII treats of prints in fabrics, prints in dyes, etc. Later chapters compose the various heliographic processes, treat of the preparation of heliographic papers, making of tracing for sun-copying, outfits for heliographic printing, giving illustrations of printing processes, etc., methods of obtaining white lines on blue ground, or blue lines on white ground, black lines on white ground, brown lines on white ground, and various minor heliographic processes, printing-house memoranda, manipulation, paper sizing, chemistry, etc.

Tennant & Ward are the American publishers of this book.

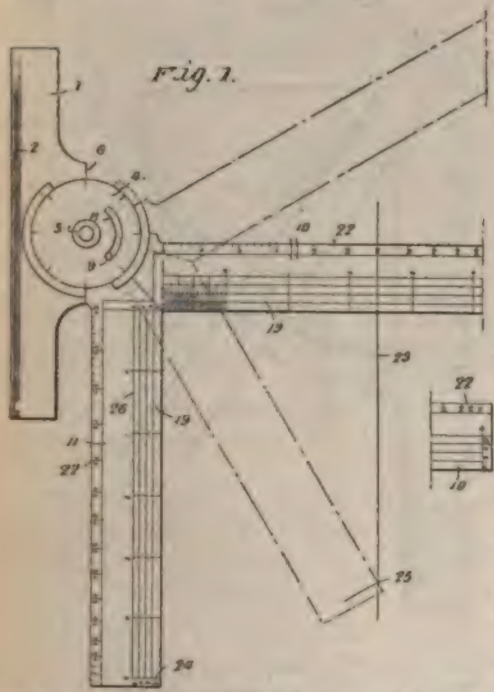
New Inventions.

The following inventions have been been specially reported for the Draftsman by C. LeRoy Parger, Solicitor of Patents, 707 G Street, Washington, D.C.

Drafting Instrument.

No. 781,737—Knut Pauli—Feb. 7, 1905.

This invention relates to drafting instruments, the object in view being to provide an instrument for the use of draftsmen and engineers, the same being so constructed and the parts thereof being so combined and arranged with relation to each other that the laying off and protracting of various angles, lines



and measurements may be expeditiously accomplished without resort to other instruments, such as a compass or dividers.

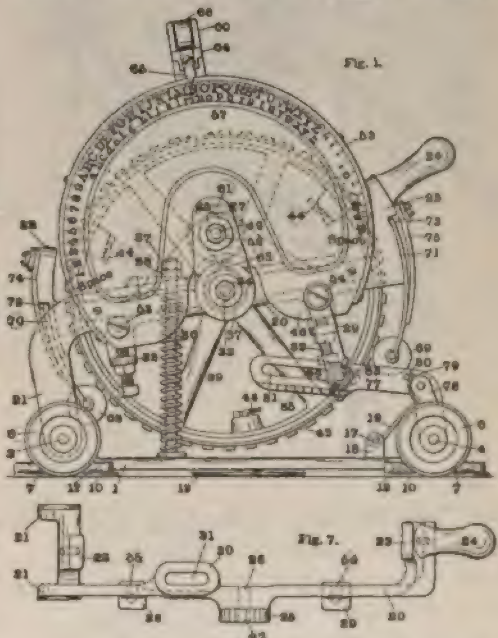
It is also the object of this invention to so combine the movable parts of the instrument that any desired angle may be obtained with the greatest possible degree of exactness, also to provide means whereby a series of interchangeable and differently graduated scales may be employed, so as to adapt the instrument as a whole to any of the various uses rendered necessary in the work of engineers, architects, and other draftsmen.

The instrument comprises a T-head, a pair of arms or rulers connected thereto by a common pivot and provided with mitered meeting shoulders, a dial connected to and movable with one arm, a vernier connected with the other arm, and a fixed vernier on the head, both verniers being adapted to register with the dial as illustrated.

Draftsman's Printing Machine.

No. 781,125—A. J. Bradley—Jan. 31, 1905.

This invention relates to printing machines, and has for its objects to produce a machine for lettering on draw-



ings, tracings, maps, blue prints, and the like; to provide a printing machine that will automatically move forward one space after each printing stroke; and to provide manually-operable means to hold

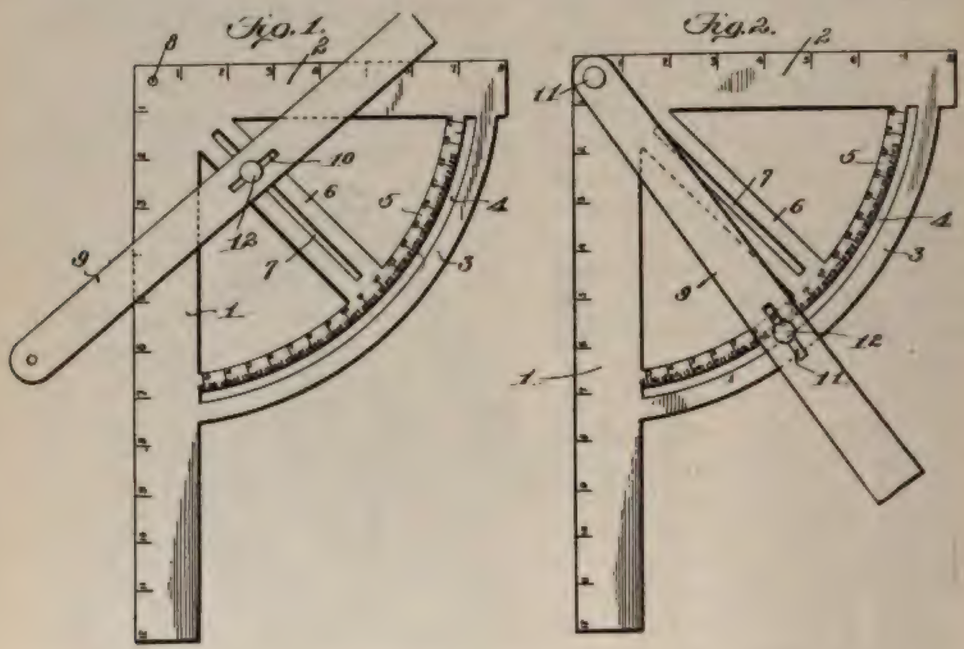
the type-wheel in any given position of adjustment and arranged to be operated in grasping the indicator.

The machine comprises a movable base, a type-carrier pivotally mounted thereon, a feed-lever pivoted on said base, and means adjustably connecting said type-carrier and said feed-lever, said feed-lever being provided with an adjustment scale.

Combination Measuring Instrument.

No. 780,954—R. L. McCartney—Jan. 24, 1905.

In combination with a square comprising a body and tongue connected by a



quadrant and an arm connecting said quadrant and said square, a blade, and means for detachably and adjustably connecting said blade to the square and the quadrant, or said arm, whereby to cause said blade to bear different relations in said respective connections to said square.

Draftsmen's Banquet.

The third annual banquet of the draftsmen of the Phoenix Iron Co., Phoenix, Pa., was held Feb. 21—05 at 6 P. M. in Masonic Hall.

The menu cards were blue prints, hand printed and consisted of two parts, the menu and the toasts.

The side of the print containing the menu was arranged as follows:

THIRD ANNUAL BANQUET
Draftsmen of Phoenix Iron Company,
Masonic Hall
Tuesday Feb. 21, 05, 6 P. M.

MENU

Bulb angles a la Newburg
(Oysters on half shell)

Phoenix standard columns, stuffed Hot slag
(Roast turkey, Filling and Giblet dressing)

Koh-I-Noor 6 H.	**Pilot Nuts.**	**Pickled rivets.**
(Celery)	**(Olives)**	**(Gherkins)**

One coat pure red lead.
(Cranberry Sauce)

Hot punchings	**Creamed Turnbuckles**
(Green Peas)	**(Potatoes)**

Cotters with linseed Oil.
(Salad)

$\frac{3}{4}$ Rounds F 2 E (Rolls) — 12" Plate with $\frac{1}{2}$ open boles (Swiss Cheese)

Cast Rosettes
(Fancy Cake)

Frozen billets.
(Ice Cream)

Assorted Scrap (Fruit) — Higgins best water proof. (Coffee)

Turned bolts $1\frac{1}{16}$ grip
(Cigars)

And the side with the toasts, as follows;

TOASTS.

C. S. Widdicombe........................Toastmaster
Selected.................. ....D. W. Bowman.
Our new office............................W. M. Watson
My first experience at house keeping...............
C. R. White
It is your move..............................S. R. Jones
Got any pennies ....S. P. Reaver
Drawing the line or how I got a skate on at Angle sea............................W. B. Oberholtzer
Our last banquet............................C. M. Spare
Views and Reviews from my window or how I managed the Circle Theatre.........F. O'Neill.
A run on the bank....................Lloyd Smoyer.
Question's or YOU have a Cinch...E. J. Costill.
As a matter of fact..................A. W. Stephens.
Reminiscences..........................D. T. Hoffman.

About 25 men were present and an enjoyable time was had by the whole company.

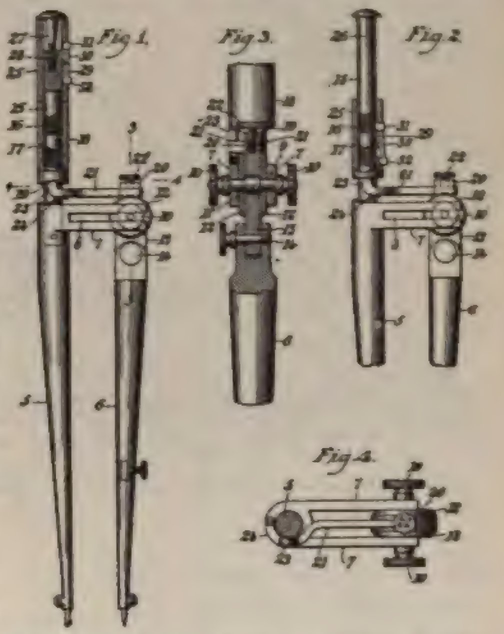
Mr. Edmund J. Costill was kind enough to supply THE DRAFTSMAN with a copy of the Menu card which is very unique. Such meetings should be encourraged and THE DRAFTSMAN will be pleased to give a report of the proceedings.

Drawing Instrument.

No. 782,662—F. E. Jenkins—Feb. 14 05.

This invention is a drawing instrument particularly designed for describing ovals and other irregular or varying outlines, the object being to provide a tool for this purpose that may be quickly adjusted for the desired lines and easily manipulated.

In the operation, when the device is used for describing ovals, the leg 6 is to be adjusted to the proper position with relation to the pivot-leg, and then the operator is to hold the sleeve 18 from rotary movement, and then, with one hand grasping the sleeve 25, the device is to be rotated. As the leg 6 moves around it is obvious that it will be swung inward and outward by means of the cam 19. When the device is used for marking out a coil, the sleeve 18 is to be re-



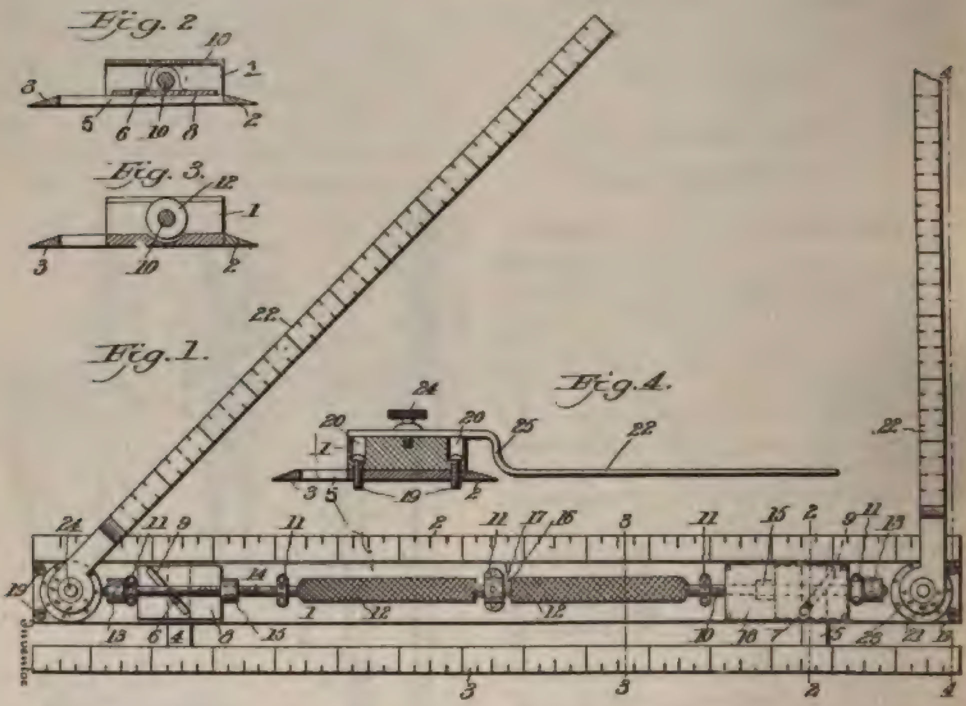
moved and the sleeve 25 moved down This sleeve 25 is to be held from rotary motion and the screw-block 31 held in engagement with the thread 16 or the block 32 held in engagement with the thread 17, depending upon the direction of rotation of the instrument—that is, to the right or left. While moving in one direction it is obvious that the coil-line will be made from the outer side inward, and when moving in the other direction the line will be made from the center outward.

Drafting Instrument.

No. 781,215—J. T. Leonard—Jan. 31, 1905.

This invention relates to drafting instruments, and has for its object to provide a ruler especially designed for the projection of parallel and radial lines.

The invention comprises a ruler having



auxiliary straight-edges disposed upon opposite sides thereof and parallel therewith, said straight edges being capable of simultaneous transverse parallel adjustment and adapted to be shifted by a rotatable shaft disposed longitudinally within the ruler.

Supplements and Data Sheets.

The following is a list of the data sheets that have been issued as supplements:

Pipe sizes,
Pipe bends,
Turnbuckles,
Ventilators,
Washers,
Key heads,
Lacing,
Morse Tapers,
Rope grooves,
Section lining.

Then there are the six sheets:

No. 1—Standard Angles.
No. 2—Rivets, Bolts, etc.
No. 3—Washers, etc.
No. 4—Beams.
No. 5—Rail Sections.
No. 6—Weight of Substances.

All sheets issued up to this time will be given with a year's subscription to The Draftsman, at $1.00. Send order early.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Machine for Grinding Piston Rings and Cams.

By A. J. BRUTSCHE.

THE readers of The Draftsman will, no doubt, be interested in a description of a machine shown Figs. 1 and 2, especially designed for machining the piston rings and cams of a gas engine, in the quickest and most accurate manner.

Fig. 1 shows the machine for grinding cast steel cams that operate the mixer and exhaust valves of a gas engine. Before this machine was built the cams were filed, it usually taking a half day to file one of these in shape, besides the wearing out of files. With this machine four of these cams can be ground in an hour, thereby effecting quite a saving.

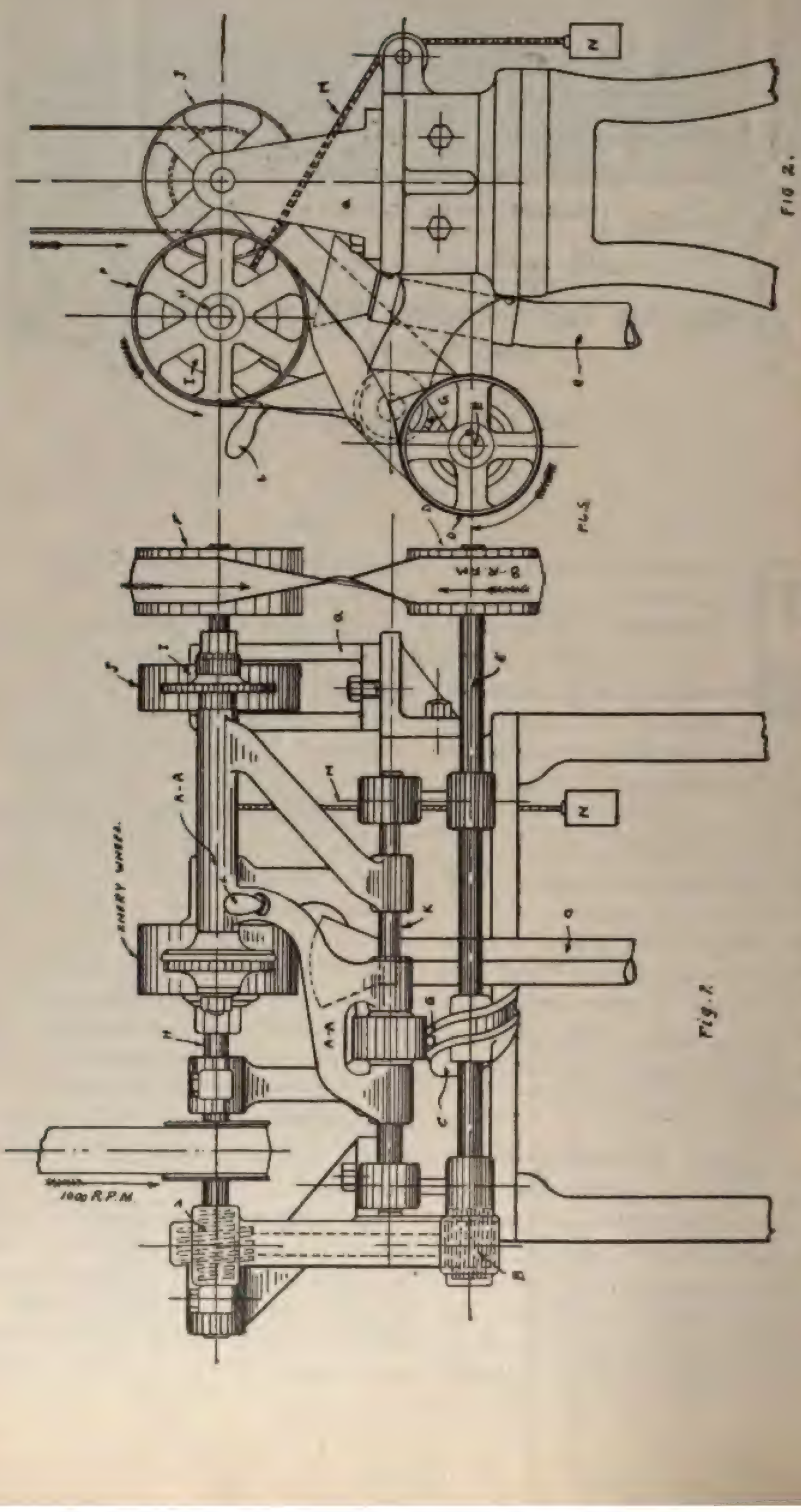
As will be seen, the machine is belt driven, operating the carriage A-A from side to side through the worms and worm gears A, B, and the cam C. The piece to be ground turns the same direction as the main spindle, through the pulley D on shaft E and pulley F on the carriage spindle, the belt making a twist so as to turn the work in the right direction.

The trunnion G on the carriage, following the groove in the cam C, gives the carriage a smooth, even motion from side to side, thereby bringing all the surface of the work to be ground in contact with the emery wheel.

The carriage spindle H must always carry a finished cam at I (instead of roller, as shown in Fig 1), which rolls on the adjusting wheel J, thus allowing only the proper amount ground off the piece to be finished. The carriage can be swung on the spindle K by pulling out on the handle L, only as far as the chain will allow (this chain not shown in cut).

The chain M and the weight N tend to keep the work in contact with the emery wheel. The emery dust falls through the spout O.

Fig. 1 shows the machine rigged for grinding piston rings. The ring casting is first rough turned on the lathe and the rings cut off the proper width. A piece is then cut out on a 45 deg. angle, as shown at P, Fig. 5. Now the ring



Machine for Grinding Piston Rings and Cams.

holder is brought into use by placing the one centering piece (shown in Fig. 7) into the holder (shown at Fig. 6). The ring is now sprung together and placed in the holder on top of the centering

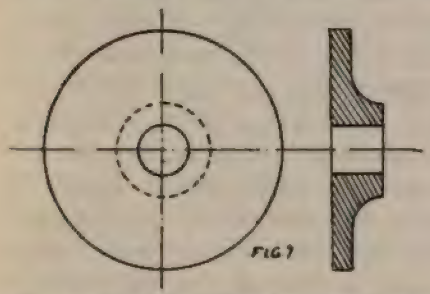


FIG. 7

piece. The other centering piece, shown at Fig. 8, is now placed on top of the piston ring, already in the holder. Fig. 3 shows the holder, piston ring, and centering pieces altogether. The whole de-

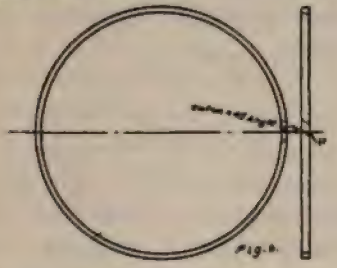


Fig. 5.

vice is now placed on the carriage spindle and securely bolted together. Now a slight tap on the side of the holder with a hammer unloosens it and the ring is

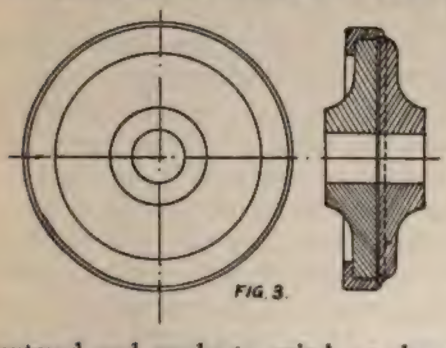


FIG. 3.

centered and ready to grind, as shown on the machine in Fig. 1, also shown with the holder off, in section at Fig. 4.

The roller I on the carriage spindle allows only the proper amount being ground off; there can be none undersize, for the roller then rolls on the adjusting wheel. The standard Q, that carries the adjusting wheel J, can be ad-

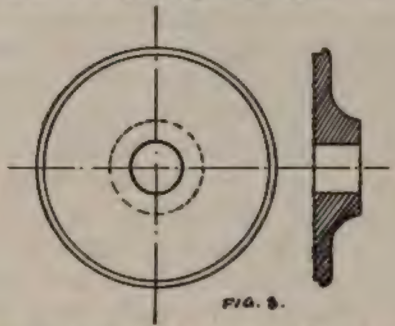


FIG. 8.

justed to take up the wear of the emery wheel. This is done by unloosening the cap screw (shown in cut) and shifting backward or forward. When finished

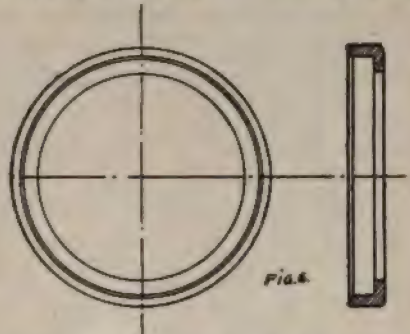


FIG. 6.

the ring is taken out and the same process gone through again for another. Heretofore the rings had been filed to make perfect fits in the cylinder, but this

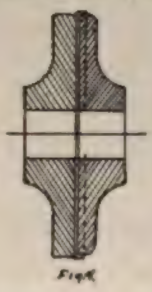


Fig. 4.

device for centering the ring and grinding is a great saver of time and the rings machined in this manner make a more perfect fit.

Bursting of Pipe Fittings.

THE bursting of cast iron fittings when subjected to steam pressure and struck with a hammer was discussed in a recent paper, read before the American Association for the Advancement of Science, by Prof. D. S. Jacobus, of Stevens Institute. In a case where a man was killed by the bursting of an elbow on a steam main near which he was working, the question arose as to the number of pieces into which such an elbow would be broken if it were struck with a hammer when under steam pressure. Tests were made on fittings of the same size and weight as the one which caused the accident and on some smaller fittings. The fitting which caused the accident was an extra heavy elbow for a 3-in. standard pipe. The smaller fittings which were tested were of 2-in. standard size and of the ordinary weight. In the tests the elbows were broken by hitting them with a hammer swung by hand when they were subjected to pressures of 80 and 100 lb. per square inch. The hammer, together with its handle, weighed 4 lb. The fittings were struck on the outside directly over each of the screw threads at points directly opposite the neck and in the plane passing through the pipe centers. The extra heavy 3-inch elbows broke in two nearly symmetrical halves, the plane of breakage being that passing through the pipe centers. The 2-in. fittings of ordinary weight broke into two to four or more irregular pieces. —"Engineering Record."

To Get Power From the Sun.

A Wisconsin mechanical engineer, named Willsie, has devoted several years to the invention and perfection of a machine to make the use of the sun's rays as a motive power a practical scheme, says an Eastern exchange. It is reported that he has at last succeeded in devising such a machine and that it is a marvel of simplicity and economy. A company has been organized to manufacture, and the first sun-operated engine will be put up at Needles, Cal.

The heat-gathering device is very simple, neither lenses nor mirrors being used. Ordinary window glass, placed over insulated troughs through which water runs, allows the sun to penetrate and become absorbed in the liquid. This absorbed heat accumulates, as it cannot escape, because of the insulation, until it has reached the point necessary, when it is conducted to the vaporizer, where it performs the same function that exhaust steam does in the regular steam engines. The temperature selected as being the most feasible is from 140 to 200 Fahrenheit.

The inventor claims that with his machine the heat of the sun can be delivered in large quantities to the vaporizer of the low temperature engine. He also says it will operate on cloudy days and in large installations as well as in small ones, and that heat can be stored for night work and for cloudy days.—"The Municipal Record."

Tests of a Steam Pipe Covering.

Tests of a steam pipe covering of asbestos 1.53 in. thick and made in flat sections 3x2 ft. in size, wrapped around the pipe and laced with copper wire, were reported recently in "The Electrician" of London, from results obtained at the National Physical Laboratory, of which Mr. R. T. Glazebrook is director. The covering averaged 2 lb. weight per running foot, or 1.7 lb. per square foot of the external surface of the 4-in. pipe used in the tests. The trials were conducted in the usual manner with a 14.34 foot length of the pipe inclined 6 inches in

this distance. The radiating surface of the pipe was 16.85 square feet. With a steam temperature of 392.7 degrees and air temperature of 67.7 degrees, the condensation of the bare pipe was 1.66 pounds steam per square foot per hour, and the heat loss 4.27 B.t.u. per square foot per hour per degree difference in temperature. With a steam temperature of 393.4 degrees and air temperature of 64 degrees, the condensation with the covered pipe was 0.212 pound per square foot per hour, or 0.54 B.t.u. per square foot per hour per degree. It was calculated that the losses with steam pressures of 190, 200, 210 and 220 pounds by gauge were, for the covered pipe, 168.4, 170.6, 172.7 and 174.6 B.t.u., respectively, per hour per square foot, and, for the bare pipe, 1.339, 1.357, 1.373 and 1.389 B.t.u., respectively.—"Construction."

An engineer declares that 50,000 people now do work with the aid of machinery which needed 16,000,000 persons to do a few years ago.

Efficiency of Ells.

QUESTION :— Please advise what is the difference in efficiency of an 18" x 14" 45-degree reducing ell, and a 14" 45-degree ell with an 18" flange on one end, to be used with steam 12,000 pounds per hour, at 27" vacuum.

ANSWER :—As we understand this proposition, the question to determine is which arrangement will create less friction; passing the steam through a 14" 45-degree ell into an 18" pipe by joining the ell to the large pipe by means of an enlarged flange, or by making an 18" x 14" reducing 45-degree ell.

Referring to Kent, page 670, on the flow of steam in pipes, we find this formula:

$$Q=4.2733\sqrt{\frac{H}{L}D^5},$$

in which Q=quantity of steam in cubic feet per hour, L is length of pipe in feet, H is length of a column of steam in feet at the entrance pressure and D is diameter of pipe in inches.

Assuming the formula to be approximately correct, it is evident that the only factors which have any influence on the question in point are L and D. If the flow is from the smaller pipe into the larger, then by abruptly increasing from 14 to 18 we must enlarge the factor D in the shortest distance without increasing L. If the passage is through a 14 x 18" ell then we increase L by the difference between the length of 14"—45-degree and a 14 x 18"—45-degree, but as an offset the factor D is enlarged by the mean diameter of the reducing fitting for the space of its length. The difference is too small to have a bearing one way or the other and may be disregarded in practice.

Should the flow be from the large to the smaller pipe, assuming that the large pipe is full and the velocity in the smaller pipe will have to be increased over that in the larger, then there should be less friction through a fitting having a taper reduction than if the transition were abrupt. Leaving out the question of wire drawing by abrupt reduction you use a larger fitting of larger mean diameter and consequently do not reach the minimum of the factor D until a later period.

The discussion appears to us to be academical rather than practical.—"Valve World."

Yard Cranes.

BY FRANK B. KLEINHANS.

A yard for storing castings is a necessity in nearly all manufacturing establishments. Many of the crowded conditions of the erecting shop would be removed by having a convenient yard near by. This is true in both the manufacture of light and heavy machinery.

In the manufacture of light machines, a large stock of castings must be carried. Competition is keen and prompt deliveries important. A large variety of castings must therefore be carried in stock, in order that there may be no delay when an order is received for a machine.

In the manufacture of heavy machinery, many large castings are required for each machine and in order to facilitate work in the foundry, it is frequently a great advantage to run castings through before the machine shop is ready for them. Unless a yard is at hand, these castings must be piled up in the foundry or machine shop and thus much useful space is occupied. Any superintendent who has had to spend three hours with one or two of the traveling cranes, in order to dig out some casting at the bottom of the heap, will agree that a yard would be a useful addition to the plant.

A yard should be arranged if possible, to admit of the least amount of handling when storing castings or in removing them. Of course, some overhead traveling cranes furnish the most convenient method in order that all parts of the yard can be served to good advantage.

To meet the general requirements for the manufacture of medium weight machinery, a yard crane of 6,000 pounds capacity would be heavy enough. This crane should serve a runway of from 50 to 150 feet in length and in width from 12 to 30 feet. The cheapest support for a crane of this capacity would be a wooden structure. The crane itself should be provided with power traverse of the bridge. The raising and the lowering of the castings could be done with a hand chain block and the movement of the trolley would also be by hand.

The general arrangement of a runway for a yard is shown in Fig. 1. This is designed for a runway of 100 feet in length and for a span of 25 feet. The height

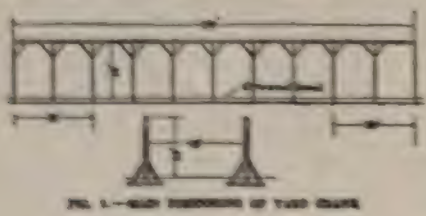


FIG. 1.—[illegible] OF YARD CRANE.

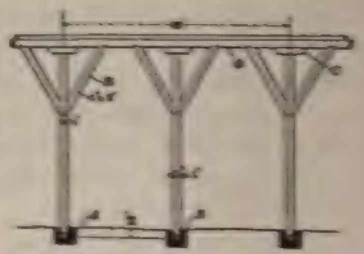


FIG. 2.—[illegible] OF YARD CRANE.

FIG. 3.—[illegible] OF YARD CRANE.

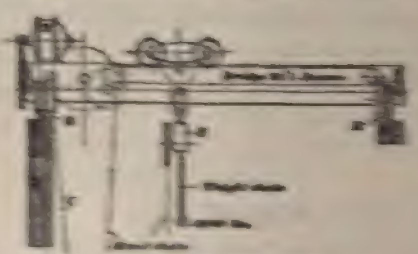


FIG. 4.—[illegible]

from the ground level to the rails would be 18 feet. The framing can be made of 8x8 inch yellow pine. A detail of this framing is shown in Fig. 2. The top beams G would be spaced 20 feet and supported on caps C as shown. The braces B would also be made of 8x9 inch yellow pine and would be notched both in the column and beams. The column would extend underneath the ground level of the yard and be supported on sills S After the runway is framed together, the whole thing is leveled with stone or cinder ballast at A, this being pounded in under the sill, in much the same way as a newly laid railway track is straightened and leveled.

A cross sectional view of this runway is shown in Fig. 3. The braces B are 8x8 inches and are notched one inch deep as shown. If the runway can be attached to a building on one or both sides the lower braces need not be as secure as shown in this illustration.

The rails would be put in place and the joints bolted together with fish plates. After the runway has been straightened and leveled the rails would be spiked down after the usual manner so as to give 25 feet center to center of rail.

The arrangement of a 6,000 pound crane is represented in Fig. 4. The hand chain block B would be hooked in the trolley link as shown. The traverse of the trolley, back and forth, would be accomplished by the use of the hand chain C. The bridge would be traversed with the motor M. The racks R and R would be bolted to the rail and would extend the full length of the runway.

The following is an estimate of the cost of a hundred foot runway crane and everything complete as described:

8x8 in. yellow pine at $28 per thousand	$ 118
Crane complete, but without motor	475
5 h. p. motor	125
Rail spikes, bolts	56
Racks, bolts, etc	76
6,000 hand chain block	78
Erection of runway, setting of crane, etc.	90
	$1,018

This amount of money could be invested to good advantage by many manufacturing concerns which are laboring under disadvantages in their foundry and machine shop.—The Foundry.

A Designing Machine.

All the readers of the *Draftsman* have seen illustrations of what is called by its promoters "The Drafting Machine," but have they ever heard of a *designing machine?* I hear someone (one of the knowing ones) say, you can make a machine do most anything except think; you cannot imbue inanimate matter with brains. Very true. Matter *cannot* be made to think, neither can some persons. Reason is the last faculty of the mind to develop, so psychologists inform us. The power to concentrate the mind on a subject, giving it *systematic thought*, eliminating non-consequentials and finally arriving at a decision which is the embodiment of good judgment to the writer, seems the highest development of the mind. It is certainly the final court of appeal in designing.

If figures, for strength, show abnormal proportions, good judgment at once tells us that there is something wrong in the application of the theory. Very often we make several assumptions which are not facts in a strict sense, and when theory and figures are applied we get an abortion, i. e., the results of premature decision are what is sometimes termed "snap judgment." The real cause is either lack of thought or wrong thinking.

Why do draftsmen omit important di-

mensions, put a dimension over top of a net work of lines or in unlooked-for or out-of-the-way places, or give numerous figures which are of no use to anyone, not even to themselves? Answer, because they don't think.

Reader, (you who are young at the business, for the old veterans either have developed or have become hopeless cases), the sooner you commence *to think* the sooner you will become valuable to your employer. The sooner you commence to realize that even the most insignificant of the elements with which you deal are pregnant with truth, to him who but looks for it, and that concentration of *systematic thought* is absolutely essential, the sooner you will find yourself upon the road of development.

The following is a concrete example of thinking: There were required on a certain job a thousand or so of oak blocks, 8x12 and 10x12, 2′ 0″ and 2′ 6″ long, all of a very similar design, but each one varying somewhat in respect to the beveled face, size of hole, etc. Fig. 3 shows cross-section of one of them. The dimension C_1 was one of three constants 4″, 4½″ or 5″, the illustrations are of the variety in which $C_1 = 4''$. A rod with upset end passed through the hole and a cast iron washer of special design took its bearing on the beveled face of the block. It is not the purpose of the writer to go into the detail of the whys and wherefors of the design which made these blocks necessary, but only to illustrate the method of determining the dimensions.

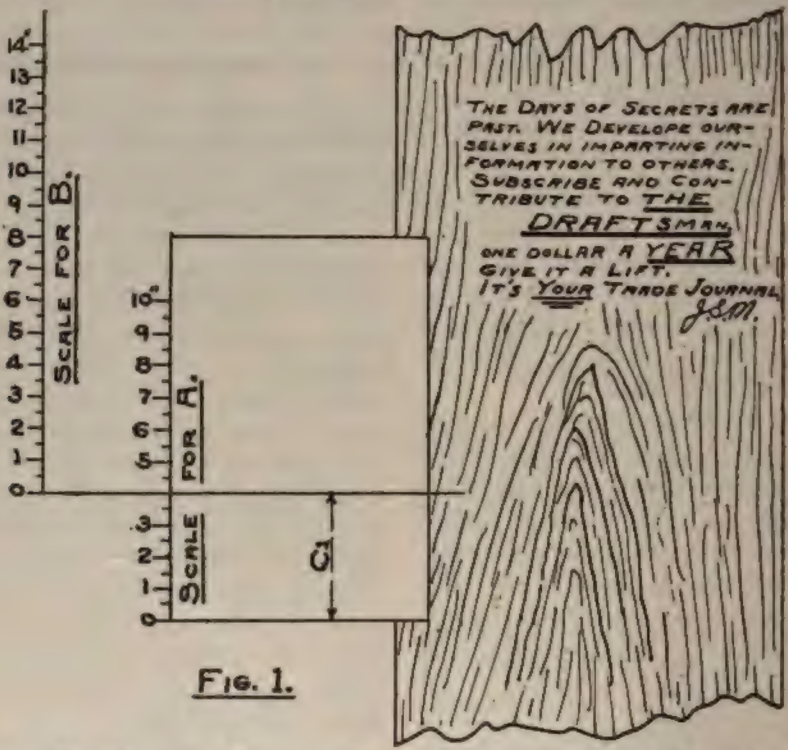


FIG. 1.

Our cardinal principle is *think*, and do it systematically.

The method of procedure was about as follows:

1. Stage of design—

That point where the detail of blocks must be taken up in order to proceed with other work dependent upon them.

2. Points previously determined—

Batter of rods (B), size of rods, size

of upset ends, dimension C_1 the general dimensions of blocks i. e. 8x12 and 10x12.

3. Are general dimensions accurate? No. They may vary possibly ¼". Would it be proper to fix them at 7¾x11¾ and 9¾x11¾? No. Why? That would tie one up too hard and fast, suggest surfaced stock, etc., etc. Deduction: system of dimensioning *must allow flexibility.*

4. What dimensions are needed? Those for face of block and size and location of hole.

Considering 3 and 4 jointly, the dimensions A, B, C and D (all of which are variables) were decided upon, C_1 and L being tabulated for use of drafting room and not given on working drawings.

5. Method of determining the values of these dimensions: (a), method; lay out each block to convenient scale; (b), method; calculate the respective dimensions; (c), method; construct some sort of chart from which to read the values required. (The reader must bear in mind that there was a great number of these blocks and that they were *the* salient feature of the construction).

By a process of elimination a and b were disposed of and c method chosen.

This method, as developed, is illustrated in Figs. 1, 2 and 3.

Fig. 3 is a section through the block on the center line of hole, as it would be given on the drawing. To this would be appended a long list, giving values of A, B, C and D for each individual block.

Fig. 1 represents the block before being cut to form of Fig. 3. The scales A and B are for reading off those respective dimensions. The B scale is placed at a distance of 12" from the rear face of the block and thus measures the batter or bevel of the rod in 12". By an inspection it will be seen that this is equal in value to B of Fig 3.

In Fig. 2, X-X represents the axis or center line of the rod and the line upon which scale C is given represents the beveled face of the block. Upon this latter line is laid off the widths of washers used for the various sizes of rods employed. Fig. 2 was made upon tracing cloth in order to be transparent. By laying it upon Fig. 1 in the proper relation all the dimensions A, B, C, C_1 and L can be read off and tabulated. It not only saves the time and labor of laying out all the lines for each individual block, but it is actually more accurate in so much that it can be made to a good big scale. It reduces the chance of error to a minimum, since there is *but one* layout used, and at the same time it shows the mutual co-relation of the quantities involved in such

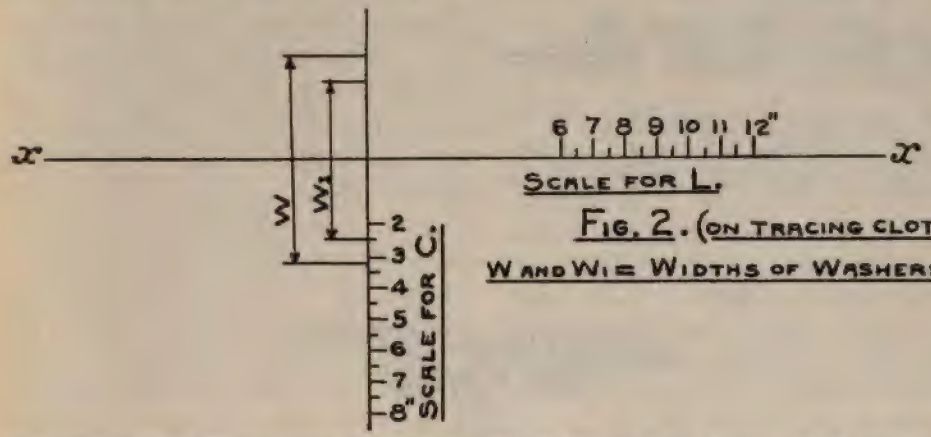
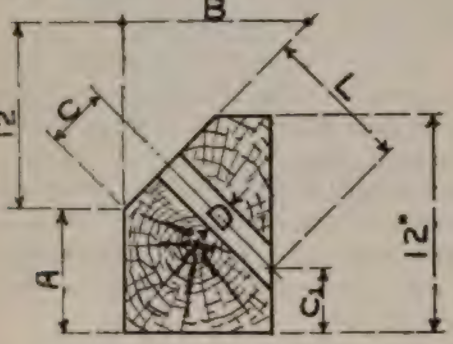


FIG. 2. (ON TRACING CLOTH.)

W AND W1 = WIDTHS OF WASHERS.

a clear manner that those values may be assigned to each with reference to what is best for all.



SECTION OF BLOCK.

FIG. 3.

C1 AND L ARE NOT TO BE GIVEN ON THE WORKING DRAWING.

The writer has nicknamed this sort of schemes, Designing Machines. He has no doubt but that there are many men doing routine work in the most cumbersome manner in which it could be done simply, because they *do not think*, or if they do it is in such a half-hearted or unsystematic manner that it is not productive of positive results.

Come on, now! Let us see, through the medium of *The Draftsman* some of the numerous, ingenious schemes which the writer knows are stored away in the minds of his fellow craftsmen, crying for liberation.

JOHN S. MYERS,
Philadelphia, Pa.
1029 Walnut St,

$350 Offered in Prizes.

The Engineering News Publishing Co., 220 Broadway, New York, announces the offer of $350 in prizes for the best papers on "The Manufacture of Concrete Blocks and Their Use in Building Construction."

ELECTRICAL.

Electricity as a Means to an End.

ELECTRICITY occupies a peculiar position in our every-day life· From the frequent use of the word one would think that it is one of those things most think that it is one of those things most essential for our happiness. This is true in a way, but how many stop to think that actually they never use electricity at all; they only use the effects which it produces. Our electric lamps give us light only because a little thread of carbon or a short column of gas is kept incandescent by heat. Our electric cars are for moving us about, not for transporting electricity. We get from the telephone and telegraph noises, and not electric currents. Electricity, then, is merely an agent by which these other actions are produced, but, happily for us, it is the most convenient and the most universally applicable agent which we have ever discovered. Exception to the general statement made above may properly be taken with respect to the use of electricity in therapeutics, an important application, but one which, for the moment, we have not in mind.

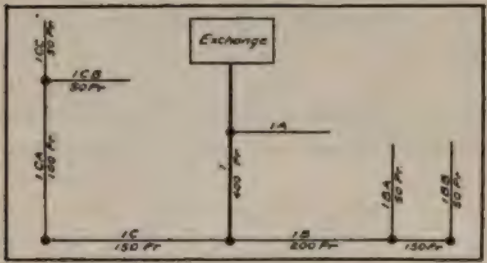
One interesting result of the peculiar position occupied by electricity is the relation of the electrical manufacturers and supply companies to the public. Who of us ever buys an incandescent lamp or a telephone? These are all bought from the makers by large companies who supply us not merely with lamps, but with light or with telephonic communication. As regards the telegraph, the same is true, and so it is with respect to the railway motor. These are all bought by large companies which have more or less of the character of public service corporations.

An exception may be made with respect to the constant-speed motor, whether for alternating or direct current. But then again, these are generally used in factories, and not by the general public. Indeed, it is somewhat remarkable that, although electricity itself does so much for us, individually we have practically nothing to do with it. There is one main reasons for this. It is because electrical energy is better for transmitting power from one point to another than any other form of energy. This is true of the telephone, for the work performed by a small vibrating sheet of iron causes a similiar sheet to vibrate in unison somewhere else. It is true of the electric lamps, for the heat which produces the light is generated by electricity, itself generated at a distant station. The convenience of the electric motor depends upon the same effect. The coal burned a mile or more away enables us to operate our machinery when and how we please, without our knowing where or how the coal is burned or the water power is employed. Elec-

tricity is, then, as was said above, merely a means to an end, but a most convenient means to almost any end.—"Electric Review."

Cable Designation Scheme.

A METHOD of designating cables that appears to possess numerous advantages is herewith described. It is particularly adapted to cables having a number of branches that would be hard to designate with numbers alone. The main cable is designated by a number



and branches of the main cable by letters A, B, C, etc.; thus branch A would be known as 1 A.

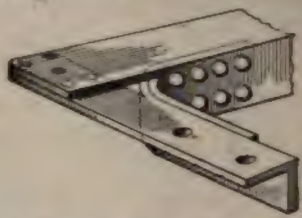
Sub-branches from cable 1 B would be known as 1 BA and 1 BB.

Branches from 1 C would be known as 1 C A, 1 C B, 1 C C, etc.

This system, owing to the different groupings of the letters, makes at once, any branch or sub-branch of a cable easily recognizable.—"American Telephone Journal."

Automobile Frame Detail.

A method for forming the corners of an angle iron frame. The ends are split and the vertical webs bent and joined as the drawing shows.



A very strong and stiff joint is thus produced.

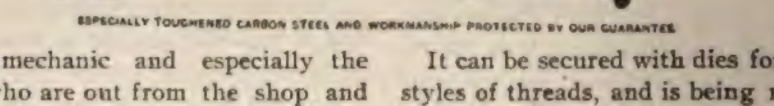
The scheme is patented by Mr. E. R. Hewitt, of New York, and recently illustrated in *The Automobile.*

He who uses electricity makes light of his troubles.

Of all bright words that pen can write,
The brightest are these, "Electric Light."

A Handy Wrench.

THE MANY USES THIS WRENCH CAN BE PUT TO ARE READILY APPARENT



ESPECIALLY TOUGHENED CARBON STEEL AND WORKMANSHIP PROTECTED BY OUR GUARANTEE

Every mechanic and especially the persons who are out from the shop and need dies for renewing threads, the Universal Grip wrench with its three dies will be highly appreciated.

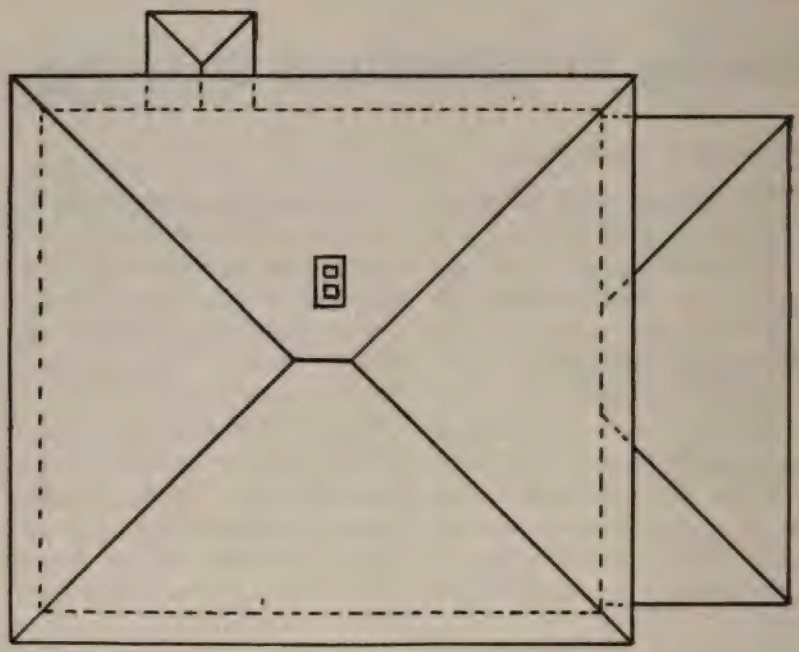
It can be secured with dies for several styles of threads, and is being manufactured by the Edmonds-Metzel Manufacturing Company, 163 Jefferson Street, Chicago, Ill.

ARCHITECTURAL.

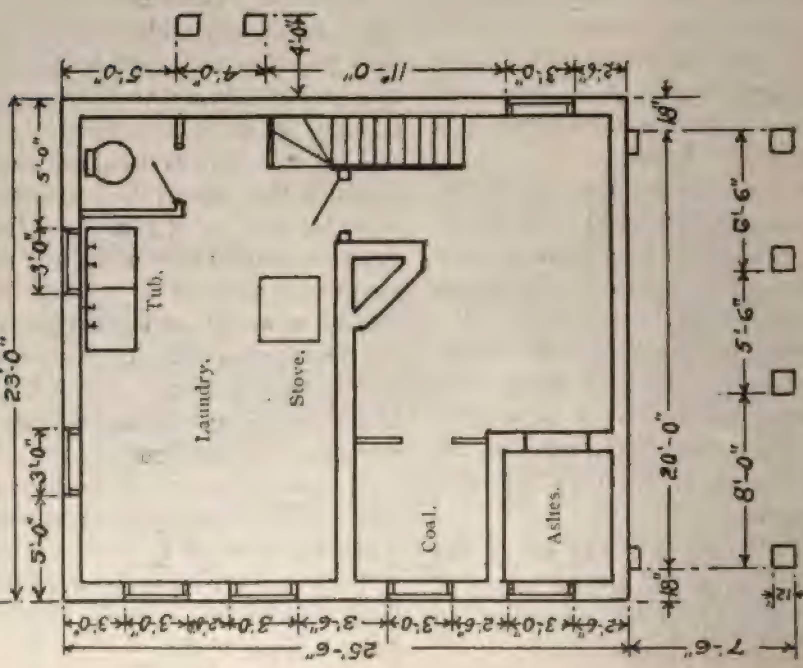
Making Architectural Drawings.

[illegible]

Illustrating Making Architectural Drawings.



Roof Plan.



Basement Plan.

MISCELLANEOUS—The closet should be 5′ 0″ x 5′ 0″ and the tubs 2′ 0″ x 5′ 0″ for two and 2′ 0″ x 7′ 6″ for three.

The stairs are of the same width as in the first floor plan and a sufficient number of steps should be shown to go down 8′ 6″ from the line of the kitchen floor at the rate of 8″ drop for each step.

The two lines at the side of the steps is intended to represent the stringer that the steps rest on.

THE ROOF PLAN—This is drawn in on this sheet so as to complete the plans for the house, for the next chapter will deal with "elevations."

The outline of the house is shown dotted to give an idea how much projection of the roof is allowed, in this case 18 inches.

The lines of the ridges or "hips" are drawn with the 45° triangle.

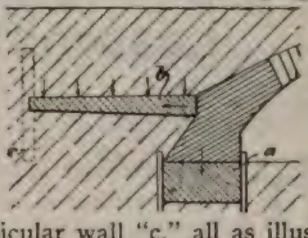
The roofs of the porches are the same as the second floor plan, in fact, a tracing may be laid over it and the roof plan constructed and inked in, the chimney being located as on the other plans and of the same size as on the second.

Weight of an Office Building.

In looking up with criticism or admiration at a modern office building probably the last question which would suggest itself to the observer is "how much does it weigh?" The mind can hardly realize the significance of figures in this connection, and yet it is not uninteresting to read of a close estimate of the exact weight of an up-to-date metropolitan steel structure, including the entire contents. The aggregate weight of one just built for the New York Times has been declared as 82,923,000 pounds. Of course the actual weight of a large part of everything used in its construction is known to the contractors who handle and bill it, as for example, the structural iron, which weighed 7,024,000 pounds.

To Strengthen an Arch.

A German patent, for strengthening the haunches of an arch, has been granted to Max Moller of Braunsehweig, Germany. It consists of a horizontal plate "b," one end of which bears against the arch and the other end bearing against a



perpendicular wall "c," all as illustrated. By this form of construction the masonry can be made much less massive.—"Cement and Eng. News."

Strength of Stone and Brick.

From an old "Scriber," Dayton, O.—Perhaps the following may be of service to "Builder," of Baltimore, Md. It is the result of tests made at the Watertown arsenal of the crushing strength of Potomac red sandstone and other building stones, brick, and brick masonry. The diagram shows the following:

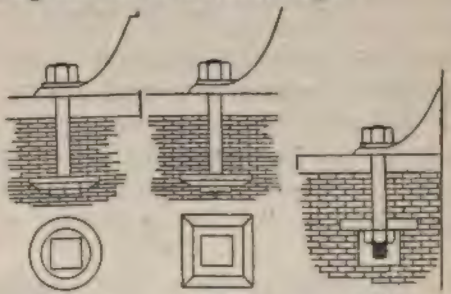


FIG. 7 FIG. 8 FIG. 9

No. of test.	Material.	Crushing strength in lb. per sq. in. From	To
6	Lee, Mass., marble	20,504	22,900
10	Potomac red sandstone	16,625	22,102
2	Coshohocken, Pa., limestone	14,090	16,340
2	Hummelstown, Pa., sandstone	12,810	13,610
6	Montgomery Co., Pa., bdue marble	9,590	13,700
3	Philadelphia pressed bricks	7,210	9,050
4	Indiana limestone	7,190	10,620
11	Philadelphia hard bricks	5,540	20,830
10	Ohio sandstone	3,940	16,280
6	Philadelphia brick masonry in cement mortar	1,600	2,685
6	Philadelphia brick masonry in lime mortar	799	1,914

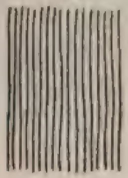
"National Builder."

ILLUSTRATING.

Lessons in Pen Drawing.

THE ability to make good pen drawings is an accomplishment worthy of serious consideration, and young penmen will find it to their advantage to give this important branch a share of attention. It has been our first aim in the preparation of these lessons to include work of the most practical nature—that class of broad, vigorous pen drawing which is adapted to general illustrative purposes. There is a constant demand for pen illustrations by engraving houses, publishers of magazines, newspapers, etc., and it is only a question of being prepared to do first-class work in order to find a market for your drawings.

1



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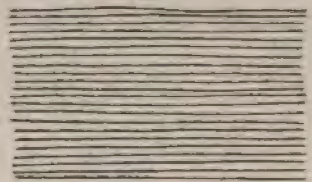

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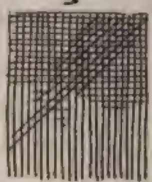

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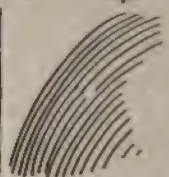

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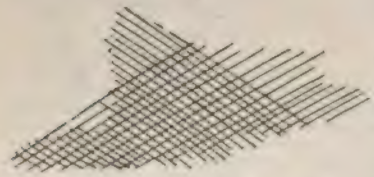

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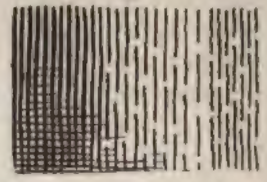

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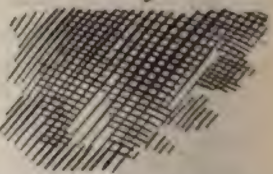
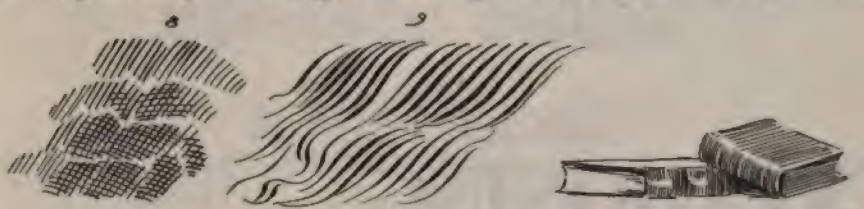


An outfit for this class of work may be simple and inexpensive, consisting of some coarse and fine pens, straight holders, cardboard or heavy paper with good pen surface, and pencils, numbers 3-H and 4-H respectively, and India ink.

The vertical lines in exercise *one* were made with the fingers. Evenness of tone depends on uniform spacing. The horizontal lines should be made with the forearm, of the same thickness, with regular spacing. Number *three* shows one method of deepening a tone, called cross-hatching. See that all the lines are of the same thickness. Make the curved strokes with the wrist and finger movements, aiming for uniform spacing to insure evenness of tone. The remaining four exercises should be executed with the fingers, moving the pen towards the body. Unevenness is often desired in drawings, and this effect is obtained by varying the thickness of the lines. See examples *six* and *seven*. Please do not run over these exercises in a careless, indifferent manner, as you must be able

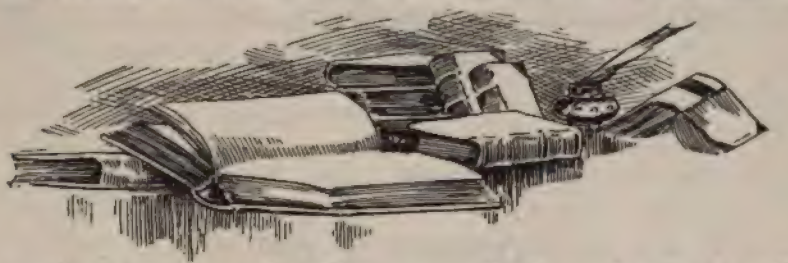
to handle the pen with freedom and accuracy, lightness and firmness, before you can do creditable pen drawing.

Do not under any circumstances use cheap writing inks in pen drawing, or for any purpose where the work is to be reproduced. A Gillott pen, number 604, is very satisfactory, and Bourgeois French India ink is easy flowing and jet black. Paris white, wedding bristol, either 2 or 3-ply, is excellent for pen work. Give the exercise for line practice especial attention. Practice on the different strokes until you can make them with precision and accuracy, with either the finger or arm movements.

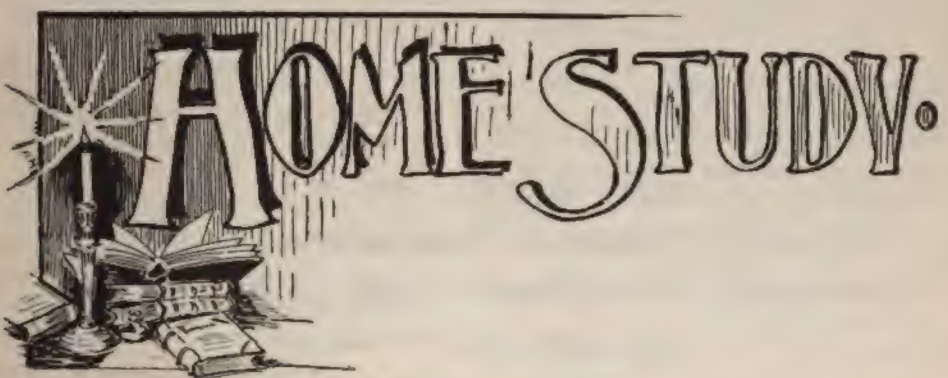


Study the design as a whole, and the form and position of each book, and do not add ink until an accurate pencil drawing has been obtained. Aim for a natural arrangement, avoiding a set, studied appearance.

Make all lines in the drawing fine, excepting, of course, places where the darkest shadows occur. Remember that the strength of a pen drawing is easily ruined by superfluous lines, and that some of the very best and most effective pen drawings comprise few well arranged lines.—"Penman's Art Journal."



An Illustration of Pen Drawing.



Lay-out of Titles on Drawings.

These should be calculated so as to space out nicely on each side of a center line, and a letter used that will not crowd the line too much.

MAP OF
MAHONING COUNTY
AND PART OF
TRUMBULL COUNTY
OHIO.

DETAILS OF
Floor Arch, Columns & Girders,
U. S. GOVERNMENT WAREHOUSE,
ROCK ISLAND ARSENAL,
ROCK ISLAND ILL.

GENERAL PLAN
HOT-BED, 28" BEAM-MILL
GARRETT-CROMWELL-ENG., CO.
CLEVELAND, O
OCT, 1904. SCALE $\frac{1}{4}$" = 1-0"

HOME STUDY.

Mechanical Designs.

Chapter VIII.

Keys and Cotters.

COTTERS.

IT is sometimes necessary to design the fastenings of a piece of machinery so that it can be readily taken apart or adjusted. An example of this is on a connecting rod of an engine where the journal brasses are fastened to the body of the rod by means of a gib and cotter. A cotter is a key which passes diametrically through a hub and its shaft to fasten them together. To take the rod apart it is only necessary to drive out the cotter, which is made with a taper fit on the gib. The taper may be about 1 in 15. For adjustment, as the brasses wear, the tapered cotter can be driven in, thus forcing the brasses, which are made in halves, against the crank pin or cross-head pin.

An illustration is shown in Fig. 1 giving dimensions of the parts of an engine connection, the same being shown finished in Fig. 2.

The rod is sometimes enlarged at the cotter so that the net sectional area at that point is equal to the body of the rod.

Let d = diam. of rod.

d_1 = diam. of enlarged part of rod at cotter.

t = thickness of cotter, usually about $\frac{d_1}{4}$.

b = breadth of cotter.

l = length of rod beyond cotter.

The sectional area of the rod is

$$\frac{\pi d^2}{4} \qquad (1)$$

and this must equal the net area at the cotter.

$$\frac{\pi d_1^2}{4} - \frac{d_1^2}{4} = (\pi - 1)\frac{d_1^2}{4} \qquad (2)$$

where $\frac{\pi d_1^2}{4}$ is the area of the enlarged portion of the rod and $\frac{d_1^2}{4}$ is equal to t or $\frac{d_1}{4}$ multiplied by the diameter of the enlarged part d_1. In other words, it is the section of the enlarged part with the hole taken out for the cotter.

Putting expressions 1 and 2 equal we have:

$$(\pi - 1)\frac{d_1^2}{4} = \frac{\pi d^2}{4} \qquad (3)$$

Solving:

$$d_1 = d\sqrt{\frac{\pi}{(\pi - 1)}} = 1.21\ d. \qquad (4)$$

If P = load on the rod and S = shearing strength of the material, which may be taken at 6,000 as a safe value for steel, then the area to resist shearing of the cotter is $2pt = \frac{b\ d_1}{2}$. (5)

Remembering that $t = \frac{d_1}{4}$. This area, multiplied by S must equal P.

Or, $\frac{b\,d_1}{2} = \frac{P}{S}$.

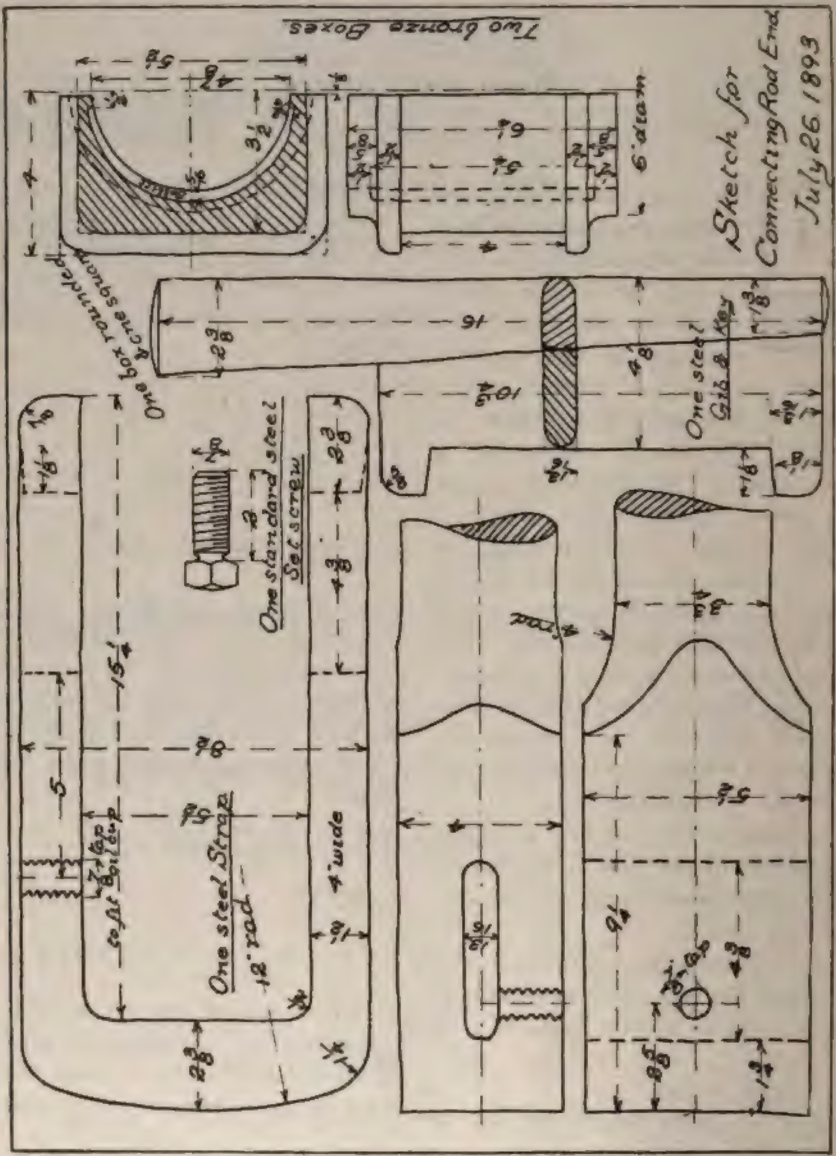
Solving: $b = \frac{2P}{d_1 S}$. (6)

The area beyond the cotter which resists shearing is $2d_1 l$, and this multiplied by S must = P.

Where the rod and cotter are made o the same material, $2d_1 l = \frac{bd_1}{2}$.

Or, $l = \frac{b}{4}$ (8

Where the gib is used, the gib an cotter may be made the same thickness



Or $2d_1 l = \frac{P}{S}$

Solving: $l = \frac{P}{2d_1 S}$ (7)

and may be designed to resist the shear together.

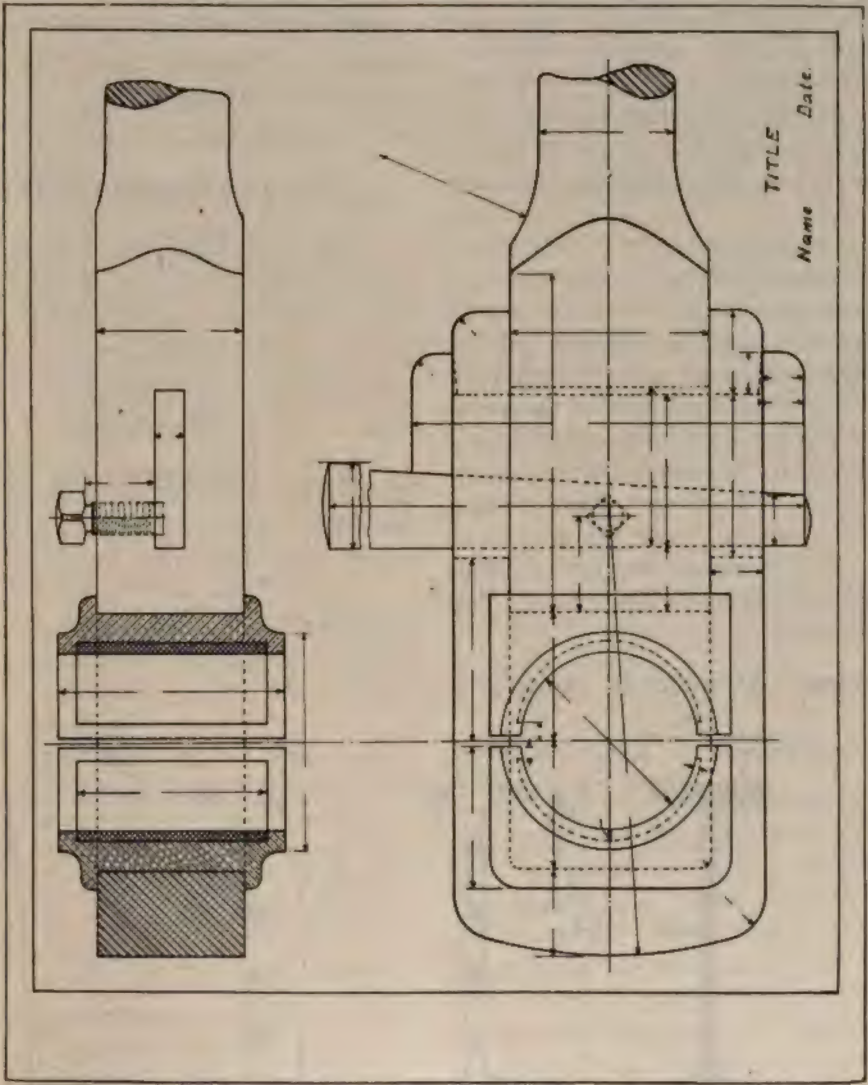
A factor of safety of about 10 should be used for cotters.

KEYS.

Pulleys, gears, couplings, etc., are fastened to their shafts by means of a rectangular strip of metal, called a key.

There are three kinds of keys in common use:

(a) Tight keys.



(b) Feather keys.

(c) Gib keys.

Class "a" is used whenever the piece is to be fastened rigidly to its shaft. They are made either square or rectangular in section and of standard sizes, the dimensions varying according to the diameter of the shaft. A table of keys can be found on page 977 of Kent's Mech. Eng. Pocket Book; also "Chapter on Pulleys," by The Draftsman. Feather keys are like tight keys in section but are somewhat different in size. They are used whenever it is required to have the piece slide along the shaft. They are sometimes called splines.

Gib keys are made with a head as shown in figure, so that they can be easily removed. Keys are calculated to re-

sist shearing and crushing.

The force tending to shear off or crush a key is the same as the force tending to twist the shaft. Very little of the mathematics of this subject can be given until the student is familiar with mechanics upon which the calculation depends.

The following formulæ have been found to agree with practice for keys subjected to shear:

For iron shafting—$l=1.2d$. (1)

For steel shafting—$l=1.6d$. (2)

Where l equals the length of key in one of the connected shafts and d=diam. of shaft.

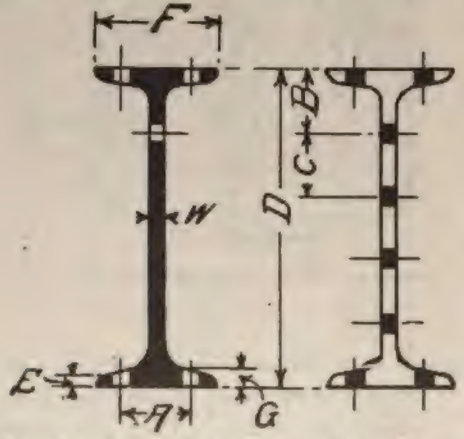
To prevent crushing:

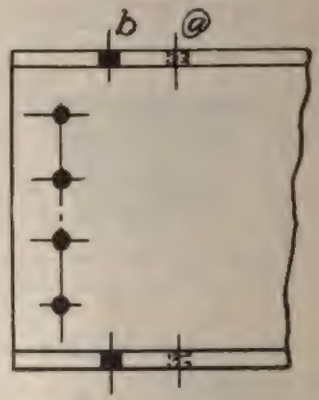
Iron shafts—$l=2.5d$. (3)

Steel shafts—$l=3\frac{1}{4}d$. (4)

These formulas assume that all the crushing force comes on half the depth of the key. Keys usually fail by crushing or distorting; therefore the last formulas should be used rather than the first ones. Keys are usually somewhat shorter than these formulas indicate. This is because the key is made of material very much harder than that of the shaft.

Drawing Structural Sections.





When the shape of an I-beam is to be shown in section, it is blackened, as in Fig. 1, and the rivet holes in the flange and web will be shown open with center lines. When the end view is shown, as in Fig. 2, the rivet holes are blackened and the center lines run through them.

In the side view there should be one line to show the edge of the flange and the rivets will be shown blackened except where it is on the rear flange.

If on the rear flange, it is put in as shown at @, with hatching lines across it, thus *b* is in the front part of the flange and @ is in the rear.

Can You Explain This?

A writer in Ryerson's Monthly says: "Some mathematical genius has proven that 4 is equal to 5 and the proof, as given to us, is quite clear, too."

Starting with the equation,

$$16-36=25-45,$$

adding $\frac{81}{4}$ to both sides of the equation, we have:

$$16-36+\frac{81}{4}=25-45+\frac{81}{4}$$

which we find is a perfect square,

$$\left\{4-\frac{9}{2}\right\}^2=\left\{5-\frac{9}{2}\right\}^2$$

and extracting the root we have

$$4-\frac{9}{2}=5-\frac{9}{2}$$

or 4=5.

Current Topics.

A Change in the Program

[illegible]

The Draftsmen Society

[illegible]

The Camera in Construction

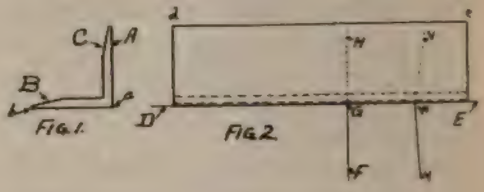
[illegible]

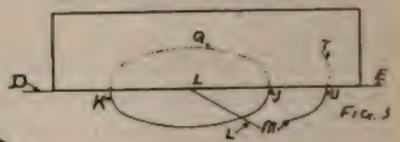
men. In fact, one of its chief advantages lies in the fact that views will often indicate, when carefully studied, possible improvements in the routine or plant. Such uses of photographs are somewhat novel, to be sure, but they have proved worthy of consideration. It is hardly necessary to point out the great value to the contractor of complete photographic records of the progress on work where there is likely to be any differences of opinion concerning the equipment and force or the rate of advance. A series of views of this character affords the best proof of a contractor's desire to carry out his work properly, and is sometimes a complete answer to the complaints sent to chief engineers by young inspectors unacquainted with all the problems which arise in handling a large undertaking.

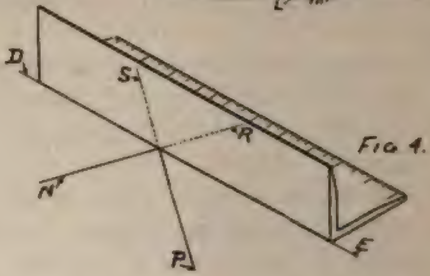
It must be understood, however, that the contractor who endeavors to take a series of good views with a camera obtained for fifty trading stamps at the corner grocery store is likely to be disappointed. So many poor contraptions are sold as cameras that care should be taken to secure an instrument fitted for the given class of work and provided with a lens which will give a clear negative. A little money paid to obtain a proper outfit will be well worth spending in many cases, while a little money saved by the selection of an inferior outfit may render the whole investment a loss. It is sometimes possible to pick up bargains in such things, but as a rule the second-hand instruments are not good for much and the low-price apparatus are incapable of good work.—"Engineering Record."

A Draftsman's Rule.

THIS invention relates to tools used by draftsmen and others whose employment involves the use of similar tools; and it consists of a rule in which one of the edges thereof is combined with a plane, preferably placed at right angles to the flat side of the rule, and having such plane provided with a reflecting surface for the purpose of utilizing the reflected image of lines previously drawn in the progress of the work in hand and by means of which reflection a line can be readily and accurately drawn at right angles to the line so reflected, or the lines of any plane angle may in like manner be readily and accurately bisected, or a circle may in like manner be readily and accur-







ately divided by diameters or its center quickly found and all this without the use of T-square, triangle, or other draftsman tool as usually used for doing such work. I attain these results by such a rule as is illustrated in the accompanying drawings, in which—

Figure 1 is an end view of my improved rule. Figs. 2 and 3 are front views, and Fig. 4 is an isometrical view of the same.

Similar letters refer to similar parts in all the figures.

Referring to Fig. 1, the angle A a b is a right angle, the edge a is a straight edge, and the vertical face A, which comprises the surface D E e d of Fig. 2, is a plain reflecting surface.

To use the rule for drawing a line at right angles to one previously drawn—as line F G of Fig. 2, for instance—the exposed part of such line will appear reflected in such reflecting-surface, as indicated by the dotted line G. H or as V W from the line W Y in the same figure, which reflection when brought in line with the exposed line G F, as in the case of the reflection H G, will locate the edge of the rule at right angles to such reflected line, and a line drawn along this edge, as the line D E will be found to be at right angles to the line F G. It will be found that the least deviation of the edge D E from a right angle with the previously-drawn line will be indicated by the reflected image being out of line with same, as shown by the line W Y and its reflected image V W. Similarly, if the rule is placed so that the reflected image of the exposed part of a circle makes a fair and true circle with that exposed part, as shown in Fig. 3, the edge D E lies on a diameter of the circle and passes through its center, so that a line traced along the edge of the ruler will be a diameter, and thus by striking two different diameters, as is shown by the lines L L and D E, the point L of their intersection will be found to be the center of the circle K J, in which Q is the reflection of same. The least deviation of the edge D E from a true diameter of the circle K J will be indicated by a want of symmetry in the reflected image with the exposed line so reflected—for instance, as is shown by the line T U, indicating the reflection of the line M U. Similarly, also, if the rule is placed so that the image of the exposed part of any two intersecting straight lines—as, for instance, as shown by S R in Fig. 4—are in line with the exposed part of the other of these lines, N P, the edge D E will direct a line which accurately bisects that angle made by the intersection of the lines in which the edge D E lies.

It is obvious that the usefulness of my said rule is increased by having its edges B and C graduated with a scale for measuring purposes, as is shown on the one edge of the rule illustrated by Fig. 4.

Patented by Albert B. Willits, of the United States Navy, residing in Philadelphia, Pa.

Drawing Compasses.

THIS invention relates to compasses used for geometrical, machine, and mathematical drawing; and my object is to provide means whereby the legs may be fixed at any distance apart, the distance being indicated in lineal measurement.

The invention is applicable to what are known as "dividers" and to pencil or pen compasses and the like.

To the inside of one leg I pivotally attach an arm, the opposite end of which is bent approximately at right angles and receives the opposite leg of the instrument. Upon this leg is marked by stamping or engraving in the usual way a scale in inches and fractions thereof, and the widths between the points of the legs of the compass are indicated by the position of the end of the arm upon the scale. The arm may entirely surround the leg and be provided with a set-screw, by means of which it may be clasped upon the leg and the width of opening of the compass thereby fixed. The arm may be grooved upon the sides facing either leg to receive the leg when the compass is closed.

The drawings herewith illustrate the invention, Figure 1 being a side view of a

pair of compasses closed and fitted with my invention; Fig. 2, a similar view with the compasses open; Fig. 3, a cross-section of the pivoted arm on line A A, Fig. 2. Fig. 4 shows a modification.

The arm 1 is pivoted by a pin 2 to the leg 3 of the compass, the end of the said arm being bent to form a socket, as shown, to receive the leg 5, which is provided with a scale 6. The arm is locked to the leg 5 by a set-screw 7. A groove 10, Fig. 3, is formed in the arm for receiving the leg 3 when the compasses are closed.

Fig 1

Fig 2

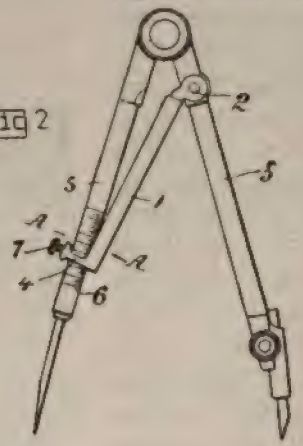


Fig 4

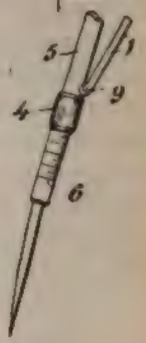
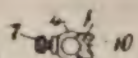


Fig 3



In the modification shown by Fig. 4 the socket 4 is pivoted by a pin 9 to the arm 1.

To use the instrument, the screw 7 is unscrewed to set free the leg 5, and upon the compasses being opened the said leg slides through the socket 4 of the arm, the distance apart of the points of the legs being shown by the position of the said socket upon the scale.

Patented by D. W. MacDonald, Havelock North, N. Z.

Slate Pencils.

IN making slate pencils broken slate is put into a mortar run by steam and pounded into small particles. Then it goes into a mill and runs into a "bolting" machine, such as is used in flouring mills, where it is "bolted"; the fine, almost inpalpable flour that results being taken to a mixing tub, where a small quantity of steatite or talc flour being essentially a hydrated silica of magnesia, which, when pure, consists of silica 62.0, magnesia water 4.9=100, which is added, together with other materials, the whole being made into a stiff dough. This dough is thoroughly kneaded by passing it several times between iron rollers. Thence it is conveyed to a table, where it is made into "charges," or short cylinders, four or five inches thick and containing eight to twelve pounds each. Four of these are placed in a strong iron chamber or "retort" with a changeable nozzle, so as to regulate the size of the pencil, and subjected to tremendous hydraulic pressure, under which the composition is pushed through the nozzle in the shape of a long cord and passes over

a sloping table set at right angles with the cords to give passage to a knife, which cuts them into lengths. They are then laid on boards to dry, and after a few hours are removed to sheets of corrugated zinc, the corrugation serving to prevent the pencil from warping during the process of baking, to which they are next subjected in a kiln, into which superheated steam is introduced in pipes, the temperature being regulated according to the requirements of the article exposed to its influence. From the kiln the articles go to the finishing room, where the ends are thrust for a second under rapidly revolving emery wheels, and withdrawn neatly and smoothly pointed. They are then packed in pasteboard boxes, each containing 100 pencils, and these boxes are in turn packed for shipment in wooden boxes containing 100 each, or 10,000 pencils in a shipping. Nearly all the work is done by boys. — "Cement and Eng. News."

Did you get a copy of the index for 1904? They are free, send for one.

Wages and Their Relation to Higher Prices.

THERE have been many notable changes in the prices paid for labor since 1894, when carpenters got $2.50 for a day of nine hours, a rate of 27 7-9 cents an hour; while in 1904 they got 37½ cents, working eight hours only, an advance of about 35 per cent. Ten years ago, bricklayers received 42 cents an hour for eight hours' work a day, and tenders 25 cents for the same hours. Today they get 55 cents and 30 cents an hour, respectively, an advance of very nearly 31 per cent for the former and 20 per cent for the latter. Stone masons were paid 42 cents an hour for eight hours' work in 1894, and their helpers received 25 cents an hour for the same length of day; but in 1904 these rates had increased to 50 and 55 cents an hour for the stone masons, and 30 cents for the helpers, the working hours remaining the same, an advance of 18 and 31 per cent for the masons and 20 per cent for their helpers. Painters in 1894 received $2.40 a day of eight hours and decorators $3 a day of nine hours; in 1904 the painters were paid $2.80 and the decorators $3 a day, hours unchanged, an increase for the former only of nearly four per cent. Roofers were paid $2.50 and $3, their helpers $2.25 and $2.50, slaters $3 and $3.50, and their helpers $2.50 a day of nine hours for all in 1894; in 1904, they received practically the same remuneration for eight hours' work, an advance of over 11 per cent. Plumbers ten years ago got $4 for nine hours' work, and their helpers $1 for the same time, no charge to be made for less than half a day's work, while in 1904 they received $3.75 and $1, respectively, for eight hours' work, an advance of about 5½ per cent for the plumbers only. Plasterers were paid 45 cents and plasterers' laborers 30 cents an hour for 47 hours' work a week in 1894, while in 1904 they got 50 cents and 34 cents an hour, respectively, for 44 hours a week, and advance of 11½ per cent for the former and 13 1-3 per cent for the latter.

From the foregoing, an average of the percentages of increase in the cost of 14 materials used in the construction of wooden houses is 35.9 per cent, while the advance in the wages paid in 11 working trades averages 18.11 per cent.— "Tengwall Talk."

Send 25c. for four good back copies of THE DRAFTSMAN.

Notice the number of positions open?

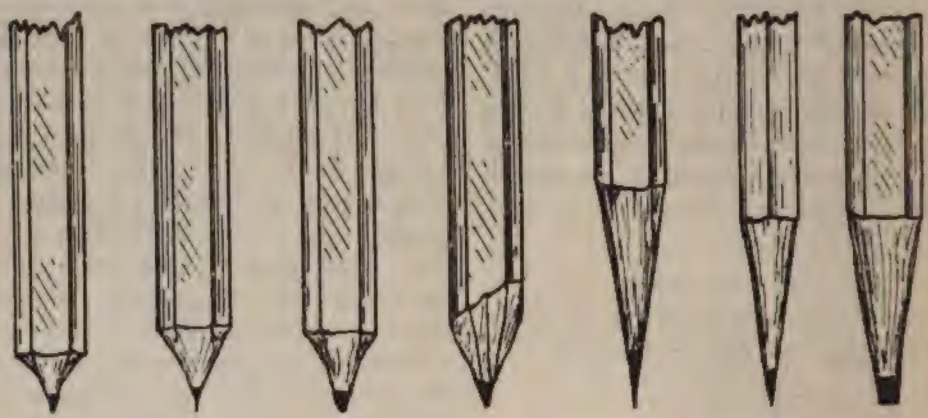
Pencil Points.

There is, perhaps, no two draftsmen who sharpen a pencil the same way and it might be said that a draftsman is known by the pencil he keeps.

Many draftsmen agree on a certain kind of pencil giving the best results, sometimes the purchasing agent determines the kind to be used and he oftentimes is governed by the price.

But back to the point, that part that really determines the looks of a drawing.

The style of sharpening depends on facilities, a pocket knife, a pencil pointer worked by the fingers or one operated by a crank handle are the usual methods to reduce a pencil to a point, be it dull or sharp.



1 2 3 4 5 6 7

The point shown in No. 1 was probably cut quickly, leaving much wood to stiffen the lead and was to be used where considerable pressure was necessary. If this be sandpapered it would retain a fine point only for a short time.

No. 2 and 3 are twin brothers of the first, No. 3 being a side view of No. 2, No. 1 being round while No. 2 is flat.

No. 4 is the point of a pencil of a slovenly man, he is too lazy to put a good point on it and his work will often bear out the above consideration of his character.

No. 5 when round shows a careful man, one who wishes his tools to be just right and who, no doubt, will make very neat work.

It is a point that will only need sanding to keep it in good shape for a considerable time.

In Nos. 6 and 7 we have the wedge or chisel point, common with some men, liked by some, but despised by others.

A slight twist of the pencil when being draw along the straight edge will make a thick and thin line, this is the objection.

Draftsmen who use this style of point often have the other end of the pencil sharpened as in No. 5 for figuring, some have a round pointed pencil lying handy for that purpose.

Since we are writing about pencils it might be well to remark on the evident carelessness of some draftsmen to carry lines much farther than needed and then not to rub them off, but expect the tracers to tell where to stop. This is especially true where the draftsman is in the habit of running the projecting lines into the object.

The object should be clear and distinct with projection lines not touching it, and the dimension lines broken to receive the dimension.*

Bisecting Divides.

THIS invention relates to bisecting dividers having for its object a simple and accurate instrument of this kind; and it consists in certain novel features of construction here described.

In the accompanying drawing, Fig. 1 is an elevation of the invention, and Fig. 2 a vertical section thereof. Fig. 3 is a plan view. Fig. 4 is an elevation of the sleeve referred to hereinafter, and Fig. 5 is a vertical section thereof.

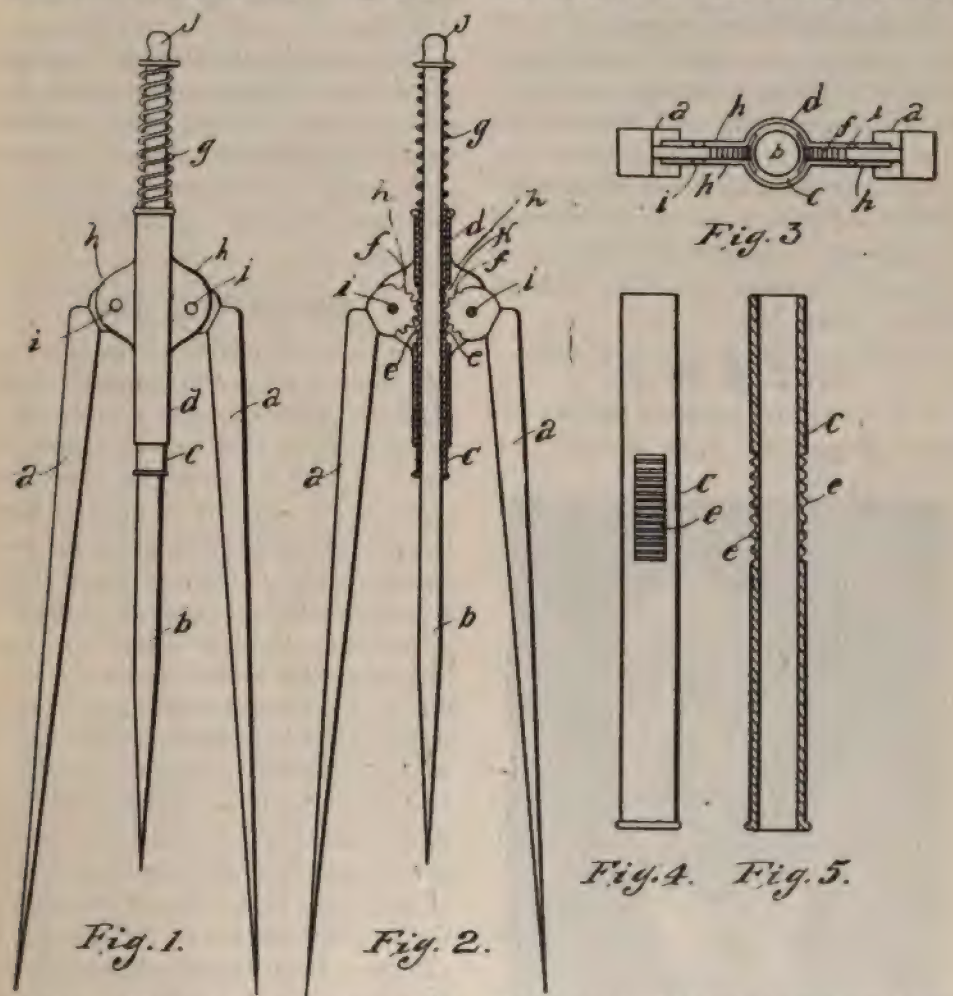


Fig. 1. Fig. 2. Fig. 3 Fig. 4. Fig. 5.

Referring specifically to the drawings, the divider has three legs, the outside legs being indicated at a and the center leg at b. The legs are pointed, as is usual in instruments of this kind. The leg b is formed of steel or other suitable metal rod and has at its upper end a cap j. The leg b slides in a sleeve c, which sleeve has rack-teeth e cut on each side of its outer surface. The sleeve c also telescopes or fits in an outer sleeve d, which has on each side outwardly-extending ears h, between which the legs a are pivoted, as at i. The said legs a are formed at their upper ends into a toothed segment f, which meshes with the rack e on the sleeve c, the outer sleeve d being slotted, as at k, to allow the segment to contact with the rack. It will be apparent that when one of the legs a is spread the

other leg a will also be spread the same distance and both legs will be equidistant from the center leg b.

The leg b, as heretofore described, fits loosely in the sleeve c, and it is held up by means of a spring g, which fits between the cap j and a shoulder on the top of the sleeve d. This spring keeps the point of the leg b off the paper when the legs a are spread.

The instrument can be used with one hand holding it as usual for such instruments and spreading the legs as desired, the first finger being used for pressing down the leg a to mark the center.

The instrument is simple in construction and not liable to get out of order and well serves the purpose for which it is intended.—Patented by Peter Jelsma, Guthrie, Okla. Ter.

Mr. E. B. Moore.

It is with great pleasure that we are able to present Mr. E. B. Moore to our

readers. Mr. Moore, a young man of 16 years, unaided, has completed and published a neat book on "Wire and Wireless Telegraphy." The book treats on the Growth of the Electric Telegraph, Substance Ether and Waves, Wireless Instruments, Marconi's Cape Cod Station, Wireless Telegraph on Sea, and is well written and illustrated.

Mr. Moore is also advertising electrical supplies and proposes to do business along that line as well as the publishing of books.

There must be something in the atmosphere around the place (Springfield, Vt.) to induce such a young man to get out and hustle and make a name for himself.

We make our best bow to Mr. Moore for producing such creditable a piece of work.

Contracting, Etc.

The technical schools report each year that there is a demand for more young graduates than they can supply. It is therefore likely that for the present the senior in such a college can make some choice in his selection of his first work. But with the steady increase in the number of students in these institutions there is a corresponding approach to the time when technical education will cease to insure an engineering engagement immediately following graduation. This increase in their numbers indicates the advantage to some young engineers of becoming contractors. Twenty-five years ago such a career would have been regarded as a step downward, but nothing of the sort is true today, when many of the leading members of the national engineering societies are engaged in this pursuit.

The average engineering work requires two classes of ability, one which is strongest in planning, and the other strongest in construction. Formerly engineering knowledge was mainly concentrated in the first class. This resulted in costly

New Quarters

Civil Service Examinations

Applicants should bring with them to the examination room the necessary drawing instruments, scale, ink, and a drawing board at least 15 inches square.

Age limit, 20 years or over on the date of the examinations.

These examinations are open to all citizens of the United States who comply with the requirements.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for list of places and for application Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for these examinations the exact title as given at the head of this announcement should be used in the application.

CABLE FOREMAN.

The United States Civil Service Commission announces an examination on April 26, 1905, to secure eligibles from which to make certification to fill the following vacancies in the positions of assistant cable foreman and cable foreman in the Signal Service, at salaries from $55 to $90 per month; One on the cable ship "Burnside," on the Alaskan coast; one on the "Field," on the Atlantic coast; one on the "Ingalls," at Manila, Philippine Islands, and other similar vacancies as they may occur. The stations of these ships are temporary and liable to change.

Age limit, 21 to 50 years on the date of examination.

Only persons who are physically sound and able-bodied will be admitted to this examination.

This examination is open to all citizens of the United States who comply with the requirements.

Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any place mentioned in the accompanying list, for application Form 1093. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

Examinations for positions as Instructor in Carriage Making, Boiler Maker, Carpenter and Coppersmith to take place April 14th and 15th, respectively, are also announced, but were received too late for our March issue.

TOPOGRAPHIC DRAFTSMAN, DYNAMO TENDER AND INSPECTOR OF CONSTRUCTION.

The commission further announces examinations for above positions May 3.

Book Reviews.

A series of books on a number of useful subjects has been prepared by Spon & Chamberlain, 123 Liberty street, New York, N. Y. This series comprises such books as: Study of Electricity for Beginners, Dry Batteries, Electrical Circuits and Diagrams, Electric Bells and Alarms, Small Dynamos and Motors, Induction Coils, Model Boiler Making, Joint Wiping, Steam Turbines, Woodwork Joints, etc., etc. All are well illustrated and printed on good paper and treat the subject in hand in a simple but concise manner. The books are bound in paper, price 25 cents each. Full lists may be had for the asking.

Spain produced 175,109 tons of lead in 1904, exceeding the output of all other countries except the United States. Mexico is the third largest producer, and Australia comes fourth in order.

Did you get a copy of the index for 1904? They are free, send for one.

THE DRAFTSMAN

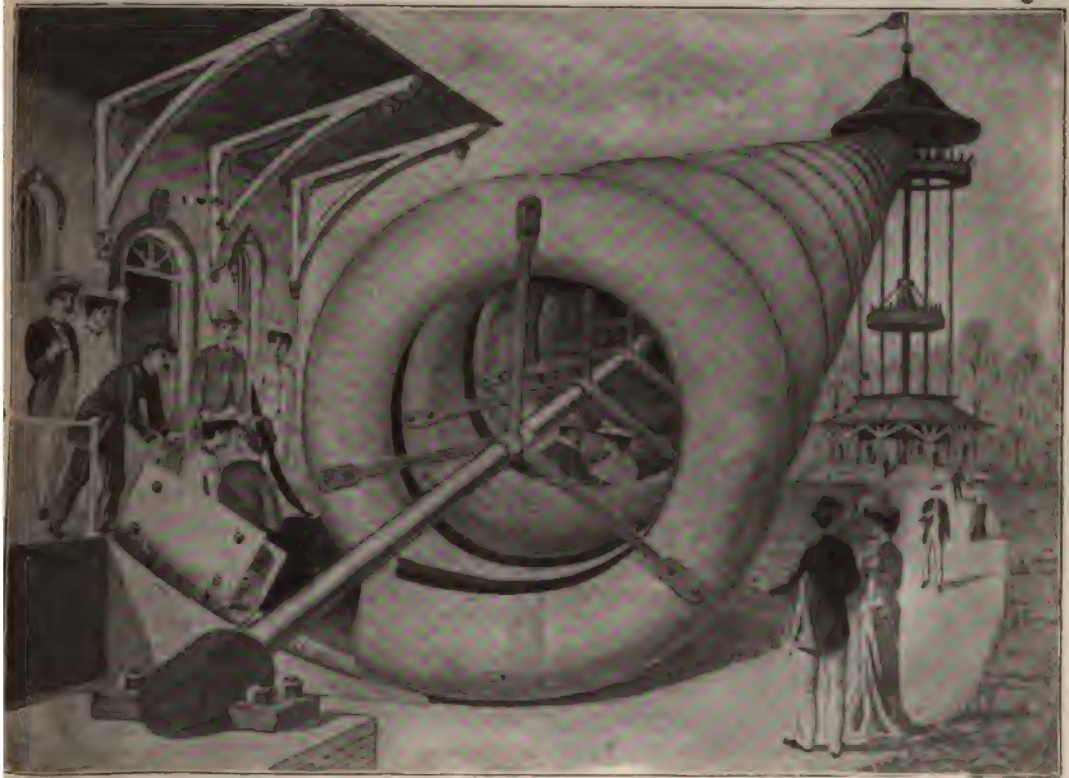
Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

The Archimedean Screw.

The Archimedean screw (called also the spiral pump), a machine for raising water, was said to have been invented by Archimedes, an ancient scientist, born at Syracuse about 287 B. C. He designed it during his stay in Egypt for draining and irrigating the land. It consists of a flexible tube bent as a helix, round a solid cylinder, the ends of which are furnished with bearings.

The machine is placed in an inclined position so that the lower mouth of the tube may dip below the water and by revolving the machine the water gradually rises. Our illustration shows a novel use of the principle of the Archimedean screw.



MECHANICAL.

The Road to Designing Machinery.

By H. C. Brandon, M. E.

IT appears strange that in spite of the manifold attainments absolutely required in the designing of machinery, it is not distinctly classified as a profession.

The prevailing tendency leans rather too strongly toward associating a machine designer with a mechanical engineer.

That the line between the two is by far too faintly drawn is evidenced on the very face of the conditions by the fact that all branches of engineering are dependent on the machine designer, making the mechanical engineer hardly less subject to the creations of the latter than the electrical steam, mining or civil engineer.

The machine designer is considered by the other professions as a sort of an adjunct, even in view of the far-reaching importance of his work.

This conception is the principal cause that colleges and technical schools do not make suitable provisions for the requirements of the future machine designer, and that even large shops and establishments afford few facilities for his development.

Many a promising young man has left the field, seeing with what difficulties he would be compelled to wrestle to fit him for a competent designer, which partly accounts for the scarcity of able men in this line, notwithstanding the fact that American designs are unequaled today.

The greatest source of trouble with regard to the position of the designer in even some of the best equipped offices is the wrong estimation of his services. Mechanical engineers mostly regard him as a superior sort of draftsman, while the superintendent of the shop treats him too much as a theorist, without the necessary practical knowledge.

Shop mechanics misjudge him quite frequently for one of those self-conscious college graduates who consider themselves above the mechanic. Still, they should remember that an immense amount of practical knowledge is paramount to anyone making claim to the title of "designer." In fact, some of the most successful machine designers have come from the ranks of the shop force.

A closer relation should exist between the drafting room and the shop, which would result beneficially to both, especially to the office man who desires to gain a perfect understanding of actual shop practice in order to apply and develop this knowledge in the arrangement of his own designs.

Referring to the requirements of the draftsman or mechanic to prepare themselves for becoming competent designers, the nature of their work and surround-

ings must be properly realized.

The draftsman must make it his duty to attain high proficiency in his work, the next step being to extend the knowledge obtained of the practical application of mechanical principles while he was engaged at the workshop of his college. The mechanic will, by long association, arrive at a thorough understanding in regard to the best mechanical execution of the work and glean considerable comprehension of the possibilities of certain devices. He will also acquire dexterity in forging, turning, pattern-making, etc.: this, however, is entirely unnecessary for the mechanic who aspires to become a designer. What he must learn is drafting. With all his shop experience he will fail in the attempt to do designing if he does not possess the ability to use his knowledge in the adaptation to new combinations of shapes and dimensions. He must investigate the reasons why certain patterns give better results than others of a kindred nature. If he has worked for a long time in a shop where some special class of machinery is made he will be quite familiar with all the parts of these machines, their shapes, sizes and functions. To him it seems that the machines are working well, and he deems it proper that all machines of a similar category should be constructed along the same lines; in other words, to him machine designing is merely a matter of observing known formulas and rules. The man with the true conception of designing will take a case in hand and, by changing some proportions, endeavor to obtain better results. Employing his familiarity with known conditions only as guides he will evolute them in striving for greater efficiency. Therefore, he must know the subject also theoretically, and to do so he must study the underlying principles.

The college graduate has a decided advantage over the mechanic in this respect. Both men are as yet unfit for designing. What the college man needs is the accumulation of practical experience; he will have to concentrate his faculties on observation and on the analyzing of existing conditions in designs. The mechanic's first step is to apply himself to studying. The method of designing may vary considerably according to the man and the result desired. It may signify a deduction from general principles or simply a matter of experimenting.

The latter method is the one employed in former times exclusively, and even to this day the same is practiced quite extensively. It is naturally a very slow way of proceeding, being brought from its crudest state by continuous alterations to a higher degree of the accomplished idea, often requiring years of application and a large expenditure of money.

While it is true that to a limited extent any new device has to undergo an evolution of this sort, it is equally true that with the possession of the enormous amount of experience gained during the last few decades, a competent designer should be enabled to construct a machine that will do the intended work to a comparatively high degree of perfection at once, providing that the principles involved are not beyond those that are well known.

Such extraordinarily large amounts of money needed in the slow experimental method has deterred a great many able men. To a certain extent it is unavoidable to make the expenditure, and machine builders in general do not reap such astounding profits, as will be readily seen when one observes that many machines are rebuilt seven or eight times before anything like approaching perfection is realized. Undoubtedly much labor and expense could be saved by not too hastily arriving at conclusions in designing; many of the errors committed might

have been omitted by a more careful and deliberate investigation of the theory. The whole cause of the trouble may sometimes rest with a misinterpretation of some phase of a principle, or, taking one thing for granted, build upon it for the achievement of another. Under all circumstances should every detail entering into the construction of the design be weighed to a minute point, and thereby not only time and expense saved, but also the denunciation of members of other branches of the engineering profession, who decry our designing as guesswork, effectively counteracted.—"*Modern Machinery.*"

Oil Burner Sure to Replace Steam Engines.

By Daniel McTavish.

The steam engine would not have lasted so long as it has but for the mechanical perfection of its design. The part it has played in the past in the development of our modern civilization was, of course, most important, but, if for two reasons only, it is doomed. It is clumsy; the energy it has made available for a thousand purposes is more than counterbalanced by the energy it has wasted. The problem appears a simple one. On the one hand we have the bottled sunlight which we call coal. On the other, we have a piece of machinery.

What is the most direct and the least costly path of procedure from the coal to the moving machinery? In the furnace the coal and air are transformed into a mixture of hot gases, but the greater part of the heat of the gases and the whole of their volume goes up the chimney. Though lost to sight, it is to memory dear, for the wastefulness of this proceeding is estimated at from 90 to 95 per cent. What will ultimately replace this clumsy and wasteful contrivance, so wonderful in its simplicity?

Nominal Horse Power.

What is meant by the term Nominal Horse Power, and has it any relation to the Indicated Horse Power of an engine? This is the question that suggests itself to every engineer, especially when he consults a catalogue with a view to purchasing an engine. The term has by no means fallen into disuse, as a study of recent catalogues of some makers of small engines will show, and its use is likely to mislead the uninitiated, as the actual horse power of an engine is usually many times its stated nominal horse power. The formula which is generally used in estimating the N.H.P. of an engine is

$$\text{N. H. P.} = \frac{D^2 \times \sqrt[3]{L}}{k}$$

where D=diameter of cylinder in inches;
L=stroke in feet;
k=a constant which varies with different makers.

Now the I.H.P. depends upon pm, the mean effective pressure in the cylinder, and the number of revolutions per minute in addition to the quantities given above, yet it is usually stated that the I.H.P. of an engine will be a certain number of times its N.H.P. The following investigation was made by the writer to find out whether this was a correct statement and, if so, what the multiplier should be.

Let it be assumed that, for any engine

$$\text{I.H.P.} = \text{N.H.P.} \times n,$$

then

$$\frac{pm \times 2L .7854 D^2 \times N}{33000} = n \times \frac{D^2 \times \sqrt[3]{L}}{k}$$

$$\therefore p\,m = \frac{n \times D^2 \times \sqrt[3]{L} \times 33000}{k \times 1.5708 \times L \times D^2 \times N}$$

$$= \frac{n}{k} \times \frac{21000}{\sqrt[3]{L^2} \times N}$$

Now, the boiler pressure and point of cut-off will be the same for all engines of the same class, and hence p m will be con-

stant. Since n and k are constants, hence, if the above is true, then

$\sqrt[3]{L^2} \times N$ = a constant for all engines of the same class. In order to find out whether this was the case, the writer referred to the catalogue of a well-known firm and from the data given deduced the values of k and $\sqrt[3]{L^2} \times N$.

It will be seen from these tables that the average value taken for k is as follows:

10 for Simple Non-Condensing Engines;

18 for Simple Condensing Engines;

16 for Compound Engines, both Condensing and Non-Condensing.

Thus, in the case of Compound Engines, the N. H. P. is the same whether condensing or non-condensing; while in the case of Simple Engines, the N. H. P. is less when condensing than when non-condensing. On examining further into the matter, it is found that the non-condensing engines are designed to work with a boiler pressure of 100 lbs., while the condensing engines work with a boiler pressure of 150 lbs. This sufficiently shows the absurdity of using a formula which takes no account of the boiler pressure. A glance at the column showing the values of $\sqrt[3]{L^2} \times N$ shows that that this is fairly constant for the same class of engine, being about 140 for simple engines and 160 for compound engines (in the case of a compound engine for D^2 we substitute the sum of the squares of the diameters of the cylinders), so that the preceding assumption is justified and the formula has a rational basis in this respect. The trouble is that the so-called constant k varies from 15 to 40 or more according to the maker of the engine, and thus the 20 N. H. P. of one maker may be the 8 N. H. P. of another maker, so that comparison is impossible. If the use of the term is retained, surely some agreement should be arrived at with regard to the value chosen for k, as in this case the term might be useful in conveying some idea of the size of the engine without regard to its speed or steam pressure.

Taking the previous formula

$$pm = \frac{n}{k} \times \frac{21000}{\sqrt[3]{L^2} \times N}$$

we get

$$n = pm \times \frac{k \sqrt[3]{L^2} \times N}{21000}$$

Thus, in the previous case, taking k = 18 and $\sqrt[3]{L^2} \times N = 150$, we get

$$n = p\,m \times \frac{18 \times 150}{21000}$$

$$= \frac{p\,m}{8} \text{ approx.}$$

Thus, if the mean effective pressure for this particular class of engine is 56 lbs. per sq. in., then n = 7, and

I.H.P. = N.H.P. × 7.

Usually n varies from 4 to 8, so that the actual H.P. of an engine is always greatly understated when its Nominal Horse Power is given.—Eng. Review.

Motor is an Improvement.

We want a prime mover which will burn its fuel in the working cylinder. Its piston will be worked by the products of combustion as their volume increases and as they expand against a steadily decreasing resistance. Or we look for a combustion engine burning continuously oil and compressed air, keeping up high pressure in a gas chest, and driving a turbine with the products of the combustion used expansively as is now done with steam. The Diesel motor is a great step in advance. At the world's fair, St. Louis, three Diesel engines drove the generators for power and light. They were of 225-horse power each, and

showed a total work per twelve hours of 2,768½ k. w. h.—i. e., about 3,711 h. p. h.

In that time they used 226 gallons of oil and the cost of the day's fuel was less than $8, working out at 1 cent for one horse power per four hours and forty minutes. They required three gallons of lubricating oil per day. Here we have efficiency much greater than in the ordinary steam engine. Time, no doubt, is required before we shall be within measurable reach of perfection. But it took 100 years to pass from a James Watt engine to a triple expansion Corliss. We may, however, count on our results. One will be the disappearance of smoke, soot and ashes. And that means no fog. And, as some railway shareholders found out last week, a few days' fog means an addition of many thousand dollars to the working expenses of the year.

The Reed Pliers.

The Reed combination pliers comprise the regular plier, a wire cutter and a screw driver. These pliers have a peculiar feature in that by a quarter turn of the handles and by sliding from one

hole to the other an unusual capacity is obtained. No doubt many of our readers are familiar with this make of pliers, which is made by Reed Manufacturing Company, Erie, Pa.

Practical Test for Turbines.

Indubitable testimony as to the relative efficiency and advantages of the turbine as compared with reciprocating engines of the most skillfully designed and perfectly balanced character is foreshadowed in the launch of the ocean liner Carmania. This vessel, a sister ship to the Caronia, which has just made its maiden trip across the Atlantic, vitally differs from the latter in that its propulsive machinery will consist of steam turbines driving three lines of shafting and propellers instead of reciprocating engines driving two lines of shafting. Identical in other respects, the performances of the two vessels on actual service are looked forward to as certain to throw great light on the efficiency of the turbine. The Coronia is also noteworthy because of mere bulk, its launch having contributed nearly one-half of the new tonnage set afloat on the Clyde during the month.

A New Method of Blasting.

Saving in the rock and ease in subsequent handling are claimed for a new method of blasting recently tried. Calcium carbide is introduced into a metallic cartridge and separated from the water necessary to its decomposition by a diaphragm, the cartridge also containing an air space and a cavity having a detonator. The cartridge is introduced into the borehole, which is tamped with a wooden plug. By striking a projecting rod the diaphragm is pierced, and five minutes later the cartridge is fired by the explosion of the detonator. With a charge of fifty grammes of carbide it is claimed that the rock is shattered, but not projected, and can be easily hewn with a pick.

Beckolith, a New Mineral.

Dr. Morosiewicz, professor of mineralogy at the University of Crakow, announced at the general meeting of the Mineralogical Society of Vienna that he has discovered a new mineral, to which he has given the name of Beckolith, in honor of the Vienna mineralogist, Prof. Frederick Beck. He asserts that it does not correspond to any of the mineral combinations so far known, but resembles mostly combinations of garnet, hav-

[illegible]

Transparent Drawing Board

[illegible]

[illegible]

Gasoline

[illegible]

[illegible]

Some Notes on Stack Raising

[illegible]

[illegible]

Setting a Wagon Scales.

The brick wall for a wagon scales 9" thick and 18" deep with dimensions of 14' 2"x 7' 2" inside took two masons and two helpers about 14 hours.

To lay out the pit, dig it and do masonry and framing it took two days' time, which includes the work of masons and carpenters.

Painting Radiators and Pipe.

Two pounds bronze and ½ gallon liquid will cover 76 loops or sections in radiators 38" high and 90' of 1¼" pipe.

Three one pint cans maroon paint will cover 106 sections in radiators 38" high.

A Premium Plan.

The Browning Engineering Co. has inaugurated a premium plan in the shop, where certain work has been done regularly for some time.

A card system is used of 3x5 cards, one side as per Fig. 1, and the other side as per Fig. 2, which will no doubt explain themselves.

Fig. 1.

THE BROWNING ENGINEERING CO.
CLEVELAND, O.

Sheet No. **PREMIUM CARD.** S. O.

Description Page Item Matl.

Name Rate Machine

Operation No. Pieces Finished

Commenced

Finished

Total Hours				Total Labor Cost			
Time Limit				Labor Cost per piece			
Premium							

Remarks

Material O. K. Work O. K. Premium O. K.

(OVER.)

Fig. 2.

EXPLANATION OF THE PREMIUM PLAN.

Under the Premium Plan a certain time, based on past records, will be allowed for the performance of any one operation. Any employe performing the work satisfactorily in less time will be paid, in addition to his regular wages, one-half the time saved, at the same rate.

The time once set will not be changed, unless new and improved machinery is introduced, or the method of doing the work changed.

If the work is not completed in the allotted time the regular rate will be paid, so there is no possible chance to lose.

No allowance will be made for defective material or workmanship unless reported before beginning work.

Over-time will be paid as usual, but the one-half time will not be charged to the working hours upon which the premium is based.

Premiums will be paid on the regular pay days, and for the same period.

ELECTRICAL.

The Tangent Galvanometer.

89.00 .... 57.2900
90.00 .... infinite

The tangent galvanometer has the decided advantage, however, of measuring a current in absolute units directly, while most of the other forms of instruments depend for their values upon the accuracy of some tangent galvanometer. The ammeter, for instance, has to be calibrated by comparing its readings to those of a known galvanometer, or by calculating the values from the amount of copper deposited upon a copper plate. In the laboratory it is customary to keep one ammeter carefully reserved for calibrating purposes. This

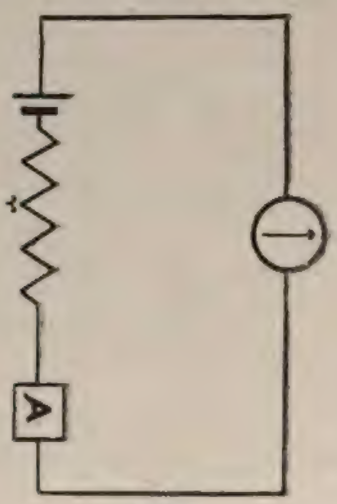


Fig. 1.

instrument is compared from time to time to the standards above mentioned and any inaccuracies are carefully recorded.

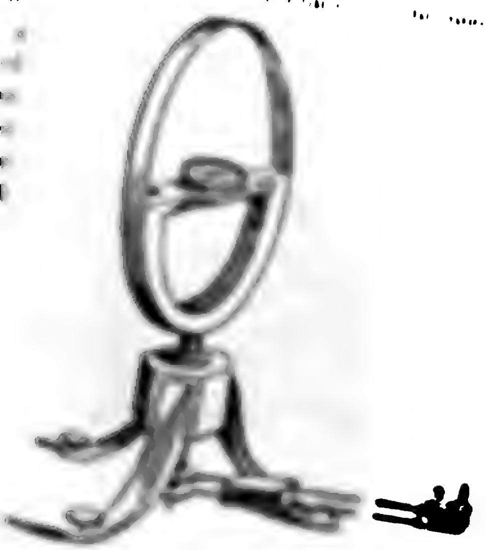
Since the earth's field varies from place to place, it will be seen that the tangent galvanometer is not a convenient thing to use as a portable current measuring instrument. Every time its position is changed a new value of the strength of the earth's field must be obtained.

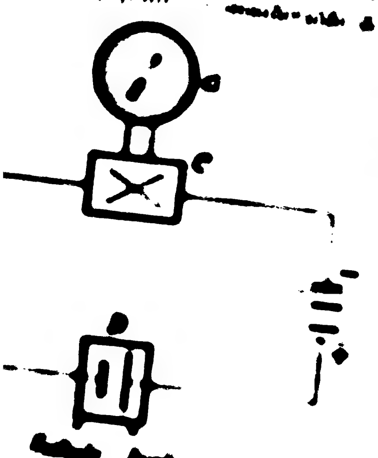
The galvanometer constant can be experimentally determined when other current measuring instruments are available. The simplest method is to connect the galvanometer in series with a good ammeter, Fig. 2, and regulate the current by a rheostat, r, so that the needle is deflected through an angle of 45 degrees. When this condition is attained, then the tangent of 45 degrees being one, we have the current equal to the constant, or,

$$I = K.$$

A galvanometer is often calibrated by using an electrolytic cell, as in Fig. 3. In this case the cell containing a solution of copper sulphate and two plates of clean copper, is connected in series with the galvanometer and a controllable resistance r. After adjusting the current by means of the resistance so that the needle gives a good deflection, the plates are taken from the cell and after being carefully cleaned and dried, are weighed. The plates are then reinserted in the cell and the current turned on. The deflection of the needle is noted at regular intervals for an hour and the average deflection computed. In reading the deflection both ends of the needle are observed and after each observation the current is reversed so that readings on the opposite side of the scale may be obtained. This is necessary in order to eliminate errors due to the fact that the plane of the coil may not be placed exactly in the plane of the magnetic meridian. The graduations on the circular scale may also be inaccurate, hence the necessity of reading both ends of the needle.

At the end of the hour the plates are taken from the cell and carefully dried and weighed. The weight of the copper deposited upon the plates will enable us to calculate the true value of the current which passed through the circuit; for it has been found by experiment that there are .0003278 grams of copper deposited by an ampere flowing for one second. Consequently the total amount of copper deposited, divided by the time in seconds





the position of the coil does not coincide with the magnetic meridian. A slow motion screw shown on the left-hand side enables one to set the coil in an exact position when desired.

Since the range of any instrument is limited on account of the fact that tangents are used to determine the values of currents, it is evident that any scheme whereby the range may be increased, adds to the value of an instrument in proportion to the amount of the increase. One of the most common methods of realizing this increase in range is by using

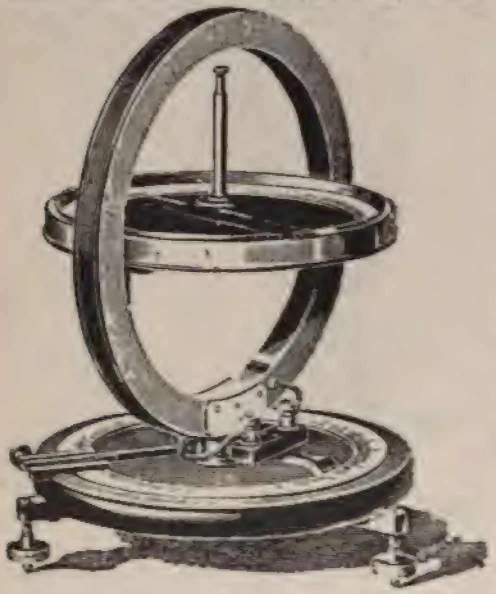


Fig. 4.

inner one being the single turn of heavy copper. This is fastened to a wooden frame, circular in form, which contains a groove filled with several turns of wire constituting the second coil. The two coils are separated by blocks of hard rubtwo or more coils placed on the same instrument. One of the coils usually consists of one turn of heavy copper wire as above described while the other coil contains several turns of smaller wire placed near the first coil, either by its side or concentric with it. Fig. 5 shows such a galvanometer provided with two coils, the ber, as shown in the figure. The magnetic needle in this instrument is very short and light. It is suspended by a fibre from the top of a brass cylinder which in turn is supported on a bar running across the coil and fastened securely to the sides. Instead of using a pointer and scale as in previously described instruments, a mirror is attached to the magnet and the deflections are noted by the reflection of a ray of light which is projected upon the mirror and then reflected upon a screen. By this means a very slight movement of the needle can be readily detected. The base of this instrument is provided with the usual leveling screws and terminal binding posts. An extra piece of apparatus must be used in order to produce the reflection of a ray of light and to measure its displacement with accuracy.

The range of many instruments is further increased by using several coils of wire and arranging these by a set of binding posts so that they may be connected in series with one another for a maximum effect, or by placing them all in parallel in order to get the minimum effect. The first combination is used when it is desired to measure a small current and the second one is used to measure a large current.

It was shown in the preceding number of this paper that the field at the center of a coil of wire is in a direction at right angles to the plane of the coil. At points close to the center but not exactly coinciding with it, the field, although in the same direction, has not the same intensity, being stronger as we recede from the central point towards the circumference of the coil. In order to use a compass needle which is supposed to be placed exactly at the center of the coil where the field is uniform, it is necessary to take into account the fact that the field varies in strength, or else to eliminate the error due to this cause by using a needle whose

Mammoth Power Plant

ARCHITECTURAL.

Calculating for Stairs.

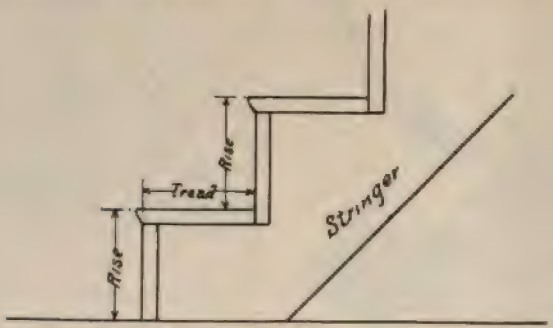
IT may not be generally understood that the part of the stairs we step on is the "tread" and the vertical height is the "riser," as shown in the sketch.

Then in calculating the stairs we must first determine the amounts for rise and tread, but the latter does not affect the figures as far as the number of steps needed are concerned.

In the following table we have a number of sizes for the risers; suppose we take 6½", then for two steps we would rise 13", and so on.

We will also need to know the distance from top of one floor to that of the next, this in feet and inches.

The rise varies from 7" to 8" in ordinary house stairs, so select the rise and pass down that column to the figure closely resembling the height of floors and then to either left or right to the outside columns for the number of treads or steps.



Each tread or step counts for a riser, since from the top of the floor to top of first step or tread is one riser.

The figure of total height can be found in the table and running up to top we may find that it will vary the rise ⅛" or more slightly one way or the other of the amount first selected.

The use for which the steps are designed determines the rise, for in a school building for small children a small amount would be necessary.

The width of the tread should be considered some for we may not have the space to go forward as we rise for the number of steps selected. If we place the foot on the tread for its whole length we will need at least 10", but this for an ordinary dwelling is not more than —.

In large halls, public buildings, etc., the tread is often as much as 15 inches, but in this case the rise is not excessive, perhaps not more than 7 inches.

After determining the number of steps we must select a tread that does not take more space for the stairs than we have to

spare.

It might be a good plan to take the tread equal to the rise and multiplying this by the number of steps, will give total space passed over in a forward direction.

Starting then at a point in the hall or room on the lower floor and counting forward we have the point of landing as we step onto the next floor.

This is not always straight ahead, for a turn is often necessary to bring the top end of the stairs to a convenient place.

COST, AND PRICES CHARGED

For Building Blocks, Sidewalks, Etc.

BY L. L. BINGHAM.

The cement block manufacturer must constantly use his pencil in order to know the exact cost of production in order to be able to make close prices on sales, as business cannot always be conducted on the block machine salesman's alluring low figures on cost of production.

Under unusually favorable conditions, their figures can no doubt be duplicated, but each cement user must find out for himself not what his lowest, but what his average cost of production is, under his own peculiar local conditions. Most of us have done this. Men with enough enterprise to attend conventions have little use for guesswork in their business; but after figuring for oneself, it is always interesting to compare notes with one's neighbors, and such is the purpose of the present paper.

In order to obtain reliable figures for reasonably accurate averages relating to cost of manufacture and selling prices of cement products, a list of thirty-six questions was mailed to 112 building block and sidewalk men in Iowa, Minnesota, Illinois, Missouri and Nebraska, requesting their co-operation. The extremes in the answers received were rejected, time being too limited to inquire into the evident unusual conditions on which they were based.

Owing to the lack of uniformity in size of the blocks made on different machines, it became necessary to first reduce the information gathered to terms of wall face feet. For instance, since each block 8 inches high and 24 inches long contains one and one-third wall feet, if an informant stated that he made 100 such blocks per day, his daily output was tabulated at 133 1-3 feet of the thickness of wall given. Nine and 10 inch walls were classed together as 10-inch, the divisions considered being 8-inch, 10-inch and 12-inch walls.

More replies having been received relative to 9-inch and 10-inch walls that size will be taken as typical. Please remember that figures given, unless otherwise stated, have reference, not to blocks, but to wall face feet.

The cost of sand at the different factories was from 0 to 4 1-2 cents per foot, ranging mainly from 1 1-2 to 2 1-2 and averaging within a small fraction of 2 cents.

By an oversight, the question of per barrel cost of cement in the different towns was omitted, but it is probably safe to arbitrarily fix it at $1.60, and interested persons should note the difference when comparing average state results with their own. On this cost per barrel of cement basis, and figuring the number of blocks per barrel made at the different factories reporting, we find the seemingly very wide range of 3 to 7 1-2 cents per foot, due partly to differing percentages of air chamber, but mainly to the proportions of cement and sand. The average was a trifle over 4 1-2 cents per foot for cement.

The *labor* expense of making blocks includes not only the moulding, but also

the sprinkling, and any necessary handling, during and after curing. The average wages paid at the different factories for skilled and unskilled labor was found to be $1.83 per day, and their average output 48 1-2 feet per man, or a labor expense of 3 4-5 cents per foot.

Summing the average of 2 cents for sand, 4 1-2 cents for cement, and 3 4-5 cents for labor, we have practically 10 1-3 cents per wall face foot as the average Iowa material and labor cost of cement blocks for a 10-inch wall. This is true only in so far as the various replies received indicate actual conditions obtaining throughout the state.

Labor and material are not the only items entering into the cost of production. Interest, depreciation, replacement and incidentals must also be taken into consideration: Interest on money invested in ground, factory, machinery, moulds, etc.; depreciation of the plant and outfit through natural wear; replacement made necessary by the rapidity with which the machinery of this growing young industry becomes antiquated—only a few months sometimes between the purchase of one machine and the invention of a better; and lastly, *incidentals*, the extent of whose yearly aggregate only one who has kept accurate accounts has any conception.

These supplementary but exceedingly important factors in cost production depend so entirely upon local conditions as scarcely to admit of satisfactory average computation. One man may use railroad ground for his site, erect a $200 shed, install a $300 outfit, let his bills run, plan to sell out to a stock company before purchasing another machine, and for the same reason keep down his incidental expenses. Another man whose present rate of production is no greater, may own a $1,000 site on which he erects a permanent factory at a cost of say $2,500, equipped it with a $2,000 outfit, and deposits another $2,000 in the bank for working capital, and invested liberally yet wisely in advertising, subscription to trade papers, purchase of cement library, postage, investigation and convention trips, etc. To many Iowa block factories, even this outlay would seem small, but they are of course heavier producers.

Within the range of conditions covered by the two imaginary cases cited is an actual one which may give force to the importance of taking into consideration the supplementary cost items mentioned.

In collecting the material for this paper, I was permitted to look over the books of a firm which last summer made forty carloads of building blocks, and nearly 30,000 square feet of walk, beside doing some other work on the side. An average sized concern. They had kept a very carefully itemized record of the business, entering separately plant cost and equipment, sand, cement, labor and incidentals. This last item footed up for the season $1,099.41. Supposing that but half of this incidental expense was properly chargeable to the building block department, and adding to that the interest on $2,500 invested in the plant and equipment, putting in $50 for the season's block breakage bill, and $200 for depreciation and replacement, and dividing this total by the 20,000 feet of blocks made, it gives us within a fraction of 5 cents per wall face foot as the legitimate and proper increased expense to add to the 10 1-3 cents material and labor cost, found to be the average, or a total actual manufacturing expense of 15 1-3 cents per foot per 10-inch wall. This 5 cents supplementary cost, however, is simply *one* firm's experience, and hence is interesting and suggestive, rather than authoritative, as applied to block manufacture in general.

Persons contemplating engaging in the building block industry should take such

additional cost into consideration until his own carefully kept records give him a basis for estimating in accordance with his own local conditions.

The per foot labor and material cost of 8-inch wall block average just about 1 cent *less*, and of 12-inch 1 2-3 cents *more* than for the 10-inch wall.

Selling prices for small lots or large contracts varied only slightly, but ranged from 12 3-4 to 22 1-2 cents for 8-inch and 10-inch, and as high as 33 1-3 cents for 12-inch, with an average of 17 1-2 cents per square foot for 8-inch wall blocks, 20 1-2 cents for 9 and 10-inch, and a fraction less than 26 cents for 12-inch.

The per foot labor and mortar cost of laying the blocks in the wall varied from 2 1-2 to 9 cents, with an average of 5 cents.

Prices charged per lineal foot for window sills and caps average 38 1-2 cents, coping 31 cents, belt course 35 cents.

Now very briefly as to cement sidewalks. The tabulated returns to the questions sent out refer only to the cost of construction of 4-inch soft walk.

The prices for sand and gravel varied from 40 cents to $2.25 per yard on the job, making an average per square foot cost of 1 1-2 cents.

For the reason already given, and because a very large proportion of sidewalk men purchase locally, the cement cost has been estimated at $2 per barrel. Some are paying more, others considerably less, but on that basis the average cost for cement is 3 3-5 cents per square foot—variations being due to differing proportions of sand and cement.

The *labor* expense was based on each informant's statement of the number of men working in a crew, their wages, and the average number of feet put in per day. This gives an average per square foot labor cost of 2 1-5 cents.

The necessary supplementary cost items in sidewalk work are much smaller than in building block estimates, being chiefly the replacement of forms and stakes, canvas and paper covers, tools mixing boxes or platforms, interest, etc. A fair estimate in my own experience was .0061 cent per square foot. If this tallies with the experience of others, it would indicate a total average state construction expense of practically 8 cents per square foot.

Prices obtained range from 8 cents to 16 cents running mainly from 10 cents to 12 1-2 cents, and averaging a trifle less, 11 1-2 cents.

Prices for 6-inch crossings averaged 18 2-3 cents per square foot, for curbings, 33 cents per lineal foot; for gutter, 17 cents; for residence steps, 45 cents per lineal foot for each riser, those with sides doubtless constituting the 50 to 60 cent class.

Average prices charged for heavy cement work were. Culverts and small arches, 27 1-2 cents per cubic foot; abutments, 23 1-3 cents; machinery foundations, 23 cents.

I wish to call attention to the possibility in a great many instances of reducing the labor item in the cost of production. Not by paying less wages; good, energetic, careful workers are more often deserving of a raise than a cut; but by judicious selection of the men, wise planning of the work, and in case of building blocks, convenient arrangement of factory and storage yard. For instance, in the making of 4-inch sidewalk, three contractors, none of whom reported the putting in of any sub-walk drainage filling, stated that their labor expense was over 3 cents per foot, an unnecessary expense as compared with the average of between $3 and $4 per day. Two building block men, using the same make of moulds working on the same sized blocks, and

both paying their men $1.75 per day, reported a labor expense difference of nearly 2 1-4 cents per block.—*Cement and Engineering News.*

Endurance of Concrete.

That concrete is the most enduring building material known is easily demonstratable. This is true in modern times and was doubtless true of ancient times. Whether the test is the power to resist the ravages of time, or its compressive and tensile strength as shown by tests of modern appliances, concrete shows itself pre-eminent and unrivaled in adaptability and general utility for innumerable purposes. Steel, stone and brick, so generally regarded can hardly be compared to this material fairly, for as evidence of its stability we have the ancient monuments of the old world.

Of what are commonly known as the seven wonders of the world, only one—the Pyramids of Egypt—now remains in original form, as monuments for their ancient greatness. The pyramids, as is generally accepted, were built of concrete. For more than 4,000 years they have reared their majestic forms above the desert and bid defiance to the eternity of time. Of them it has been said, "Time mocks all things, but the pyramids laugh at time."

The lookout towers of Ireland are supposed to have been built by the Druids more than a thousand years ago. They are constructed of concrete, cylindrical in shape, six feet in diameter and over 100 feet high. Some years ago one of these immense towers was undermined and overturned. It fell with a reverberating crash but upon examination it was found that not a crack or fracture had resulted from the fall. Had the tower been built of any natural stone it is very likely that the shock would have broken it into fragments.

And so it is with the aqueducts of Rome, built hundreds of years ago. They are of concrete without reinforcement. but still exist in nearly perfect condition. The pools of Solomon, nine miles from Jerusalem, were built entirely of concrete and still furnish the city with water. The Aurelian wall about Rome had a concrete foundation overlaid with stone. The stone was soon worn away, but the concrete which was exposed is still intact and harder than the original stone.

The cement and concrete age is spoken of, in the building world, as a new age. but we are but continuing where the ancient Romans left off. Modern science has inaugurated a renaissance of the art of producing cement of a better grade than the ancients knew. Modern architects and builders are also devising methods of reinforcement giving to concrete a strength and durability then unknown. We are building large and beautiful concrete bridges that are expected to stand forever and a day as a monument to modern progress and civilization. We are building great tunnels underneath mighty cities through which are conveyed daily endless masses to their daily avocations. We are building an immense canal to connect the Atlantic and the Pacific through which the commerce of the world will pass. Concrete is the one indispensable material entering into all these stupendous undertakings and making their construction possible at a practicable cost.

America is foremost among the nations in this modern renaissance of the cement and concrete industries. We lead the world with the possible exception of Germany,in the quantiy of cement produced. We lead the world in the varied uses of concrete. Our methods of productions and construction are the most modern. In reinforcing and fireproofing our engineers are the foremost.—Southern Architect and Building News.

HOME STUDY.

Mechanical Designs.

CHAPTER IX.

Pulleys and Fly-Wheels.

THE design of a pulley will depend upon whether it is to be used to run a belt or simply as a fly-wheel. The same pulley is often used to serve both purposes at the same time.

Four points are to be considered in the design, as follows:

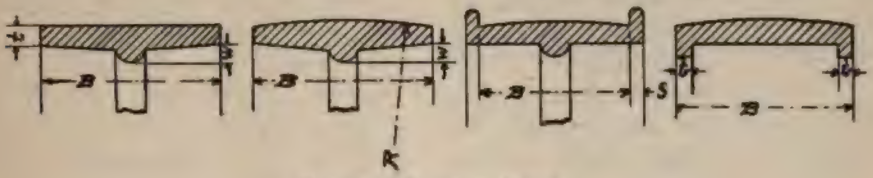
(a) Width of Rim.

(b) Thickness of Rim.

(c) Number and Size of Arms.

(d) Length and Diameter of Hub.

The width of rim or the "face" of the pulley will be determined by the amount of force that it is required to transmit,



Form of Rims or Faces.

the transmitted force being due to the friction between the pulley and the belt. Pulleys for line shafting are made to standard sizes, several widths of face being given for each diameter. Tables of standard pulleys can be found in the manufacturers' catalogues.

The amount of power that a belt will transmit is given by the formulas:

$WV=90$ h. p. for double belts

$WV=55$ h. p. for single belts

where W=width of belt in feet and V= the velocity in feet per min.

Knowing the horse power and the speed at which the pulley is to run, the width of the belt and therefore of the pulley can be determined. The rim of the pulley is made a little wider than the belt, and is crowned to prevent the belt from running off. For an explanation of the reason for this the student is referred to "A Chapter on Pulleys," published by THE DRAFTSMAN.

The stress in the rim is caused by the centrifugal force. It has been proved by experiment that the bursting speed f a pulley is about 400 feet per second for cast iron and 775 feet per second for steel pulleys.

The total value of the tensile stress on the outer surface of the rim is:

$$S=\frac{Dv^2}{tn^2}+\frac{V^2}{10}$$

Where D = diameter of pulley in inches.

v=vel. in ft. per second.

t=thickness of arm.
n=number of arms.
Solving for t:

$$t=\frac{Dv^2}{n^2\left\{S-\frac{v^2}{10}\right\}}$$

The deviation of this formula can be found in Benjamin's "Notes on Machine Design," if the student wishes to investigate it any further.

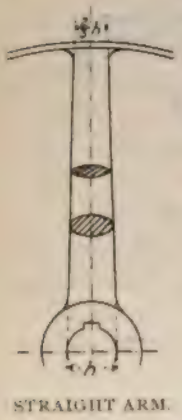
The arms of pulleys are subjected to internal stress, due to cooling of the metal in casting and also to a tensile stress, due to the centrifugal force. As both these stresses are indeterminate it is usual to design the arms to resist only the stress, due to the pull of the belt, and allow a very large factor of safety.

The number of arms may be found by the following empirical formula:

$$n = 3 + \frac{B\ D}{150}$$

where B=width of rim; D=diameter of pulley.

An ellipse is the best form of cross-section for the arms, as it offers the least resistance to the air. The arms are better made straight, as they are lighter and easier to make. The idea that crooked arms are not so liable to break from cooling strain is more imaginary than real. The size of the arm at the hub can be found as follows:



STRAIGHT ARM.

Multiply the turning force, due to the belt, by the radius of the pulley in inches, and divide this product by one-half the number of arms. This is the external load or moment, which we will call M. Then the external load is made equal to the internal resistance of the metal in the arm, or

M=S × section modulus.

The section modulus of an ellipse is

$$\frac{ba^2}{10.2}$$

Then

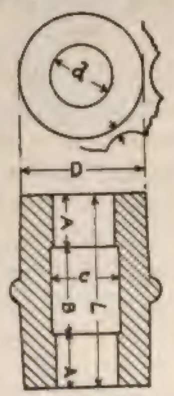
$$M=\frac{Sba^2}{10.2}$$

By putting in this equation the value of M, as found above, and a safe value for S, and solving, the values for b a^2 can be found and the size of the arm determined. A safe value for S in this case is 2,250 lbs. per square inch. The end of the arm near the rim is to be only one-half as strong as the hub end. This does not mean that the arm is to be one-half as *large* at the rim end, but it means that the section modulus at this end is to be only one-half as large, or

$$M=\frac{Sba^2}{2x10.2}$$

Substituting values for M and S and solving, as before, we get the dimensions of the arm at the rim end.

The actual diameter of the hub will depend upon the size of the shaft. A common rule is to make the outside diameter of the hub equal to twice that of the shaft. In any case the thickness of metal in a cored hub should be kept about equal to the thickness of the arm where it joins the hub. This will prevent cooling strains.



CORED HUB.

The length of the hub will depend on the length necessary to make the key to avoid being sheared off. See "Chapter on Keys," April issue of THE DRAFTSMAN.

CALCULATION FOR A C. I. PULLEY.

Take for illustration a pulley of the following dimensions: Diameter 48", width of rim 6", angular velocity 200 revs. per min., max. pull on belt 420 lbs., pulley to have 8 arms. Design the rim, arms and hub, supposing the shaft to be $2\frac{1}{2}$" diam.

The total value of the tensile stress on the rim is:

$$S = \frac{Dv^2}{2tn^2} + \frac{V^2}{10}$$

Substitute the known values for V, D and n and let S have a safe value of 1,800 lbs. per sq. inch of section of rim.

Then

$$1800 = \frac{48 \times (42)^2}{2 \times t \times (8)^2} + \frac{(42)^2}{10}$$

Solving for t:

$$t = \frac{661}{2000} \text{ or approximately } \tfrac{1}{3}''.$$

Next consider the arms. The turning pressure of the belt is 420 lbs. This multiplied by the radius of the pulley and divided by one-half the number of arms gives:

$$\frac{420 \times 24}{4} = 2520 = M.$$

Assume the arms to be elliptical in section. Then

$$M = \frac{S \times ba^2}{10.2} \text{ where } \frac{ba^2}{10.2}$$

is the section modulus of an ellipse. Let S have a safe value of 2,250, which corresponds to a factor of safety of about 16 for cast iron under transverse load.

Substituting values in formula and solving we get:

$$b\,a^2 = 14.$$

Now it is necessary to assume either the thickness or the width of the arm, so we will take b equal to one inch for a trial. Then

$$1 \times a^2 = 14$$

$$a = 3.75, \text{ nearly.}$$

The arm then will be 1" $\times$ $3\frac{3}{4}$" at the hub end.

For the rim end the equation becomes:

$$M = \frac{S\,ba^2}{2 \times 10.2}$$

whence

$$b\,a^2 = 7.$$

Taking the arm of uniform thickness, b still = 1", and

$$1 \times a^2 = 7.$$

$$a = 2.6, \text{ nearly.}$$

The rim end of the arm then will be

1" $\times$ $2\frac{5}{8}$"

The shaft being $2\frac{1}{2}$" diameter, the hub can be taken as 5" diameter.

The length of the hub, which is determined by the length of the key, can be found by reference to a previous chapter.

Drawing the U. S. Standard Thread.

A. B. Babbitt.

The following will be found a very simple yet accurate method for drawing the section of a U. S. Standard Screw Thread. First, lay off the required pitch and draw a regular V thread, as shown in Fig. 1. The second operation is to determine the inside or root diameter of the thread by means of the formula,

$$D' = D - 1.299P$$

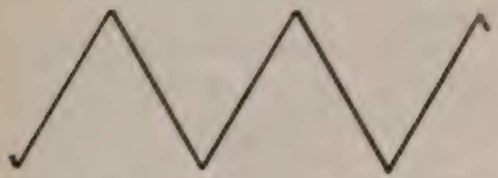
in which D is the outside diameter, D' the inside diameter, and P the pitch of the thread.

Next draw lines representing this inside diameter; these are shown at AB and CD in Fig. 2.

We now have a thread with a sharp edge at the outside diameter and a flat bottom, the flat at the bottom repre-

senting the combined flats at top and bottom of the U. S. Standard we are required to draw.

Through E, Fig. 2, draw a line perpen-



dicular to the center line of the screw and intersecting the line AB at H. Through H, draw a line parallel to EL, intersecting the line of the outside diam-

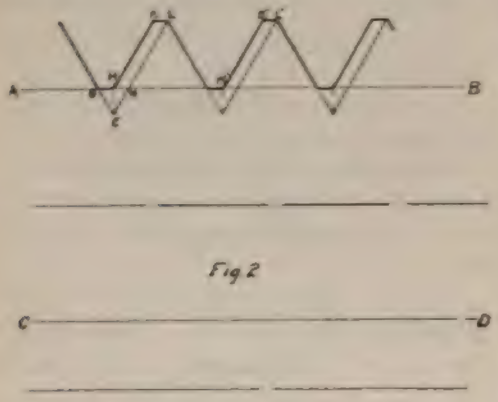


Fig 2

eter at K. The line KL will then be equal to the line HN, which is equal to HO; therefore HO is equal to KL, as required in the U. S. Standard thread.

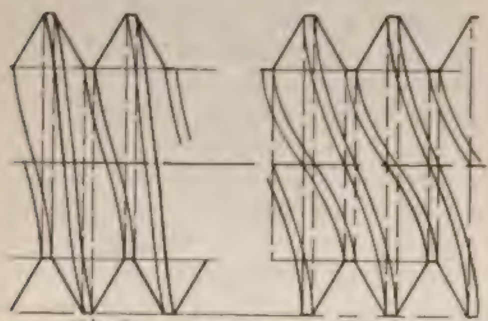
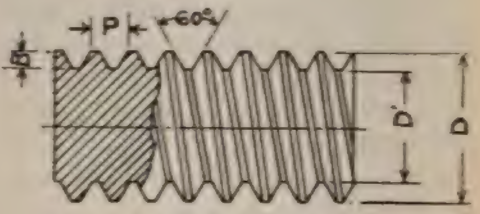


Fig 3. Fig 4

Making K′ L′ equal to KL and drawing K′ H′ the next adjacent thread may be drawn, and continuing across the upper line of the figure the section above the center line may be completed. Having completed the upper portion of the thread, the lower portion may be obtained by projecting the points on the inside diameter on the upper portion across to the outside diameter of the lower part of the thread, as indicated by dotted lines in Fig. 3. The points on the outside diameter of the lower portion may likewise be found by projecting the points on the inside diameter of the upper portion across to the outside diameter of the



P = Pitch.

B = .65 P D′ = D − 1.299 P.

U.S. Standard Thread.

lower section. After finding these points, the proper connections may be made and the complete screw thread drawn.

The principle illustrated in Fig. 3 is not applicable to the double thread, for in that case the points or flats on the outside diameters come directly opposite each other. For the double thread, then, it would be necessary to project points on the upper line at the top to the lower line at the bottom of the figure and from the lower line at the top of the upper line at the bottom. This is illustrated quite clearly in Fig. 4. In Fig. 5 are given some proportions that may be of value.

The piston speed of the average gasoline motor, that is the distance the piston would travel if it moved in one direction continuously instead of reciprocating, is about 700 feet a minute.

CURRENT TOPICS.

THERE has been a number of inquiries for our data sheets and we have prepared a list up to date, except the last ones.

We have been sending out a double one every other month, but there is a desire on the part of the readers to get them oftener.

The data sheets should contain matter not found in hand-books or some that is better arranged and more simple than there shown.

Since these go to a large class of draftsmen we will have to separate them, giving one occasionally to suit the architectural and structural men and not cater entirely to the mechanical. Some good matter has been secured for future sheets.

Requests have been made to change the color, since white paper soils so easily, hence we may do this at most any time.

We will try to secure data that has not been put in this form before, since many of our readers prefer sheets to books.

As soon as possible we will get up a binder that will hold the sheets, though the style is a little hard to decide upon.

Someone has said that two simple backs be made, with eyes, through which a common shoe lace be passed, so when the sheets are thus strung on it they may be turned over readily.

The use of the staple fasteners limit the number of sheets that can be placed between the backs. The sheets will always be 6" x 9", with greater margin at one end as heretofore, but no marks for punching will be shown.

We can furnish a punch like a pair of pliers for 25 cents.

Do not waste your breath complaining, it is not the squawking wheel that lasts the longest.

Every man should have a note book always handy for jotting down impressions. This fixes them in his memory. Sooner or later they will be found useful.

Use your position as you would a lemon. Squeeze all the good you can from it and then throw it away. Be not hasty to give up a position until you can see no more knowledge in it.

Every draftsman should make it a habit to spend part of his evenings out of doors, that the cobwebs may be blown from his brain, leaving him fresh for the combat next day. A five-mile walk at least in the twenty-four hours should be the minimum.

On a model of a recently invented automatic buffer coupling attached to two model cars now being exhibited in London the coupling not only connects the vehicles, but at the same time couples the air brakes. The outstanding feature of the invention is that no lever is required to complete the act of coupling, the whole operation being perfectly automatic. The attachment has both an up and down and a lateral movement, thus adapting itself to loaded or empty cars and to sharp curves. This model, in fact, shows the cars on a two-chain curve, more acute than any English or continental curves in existence. It is also said no alteration in the general construction of rolling stock is necessary to make the attachment to present equipment.

As a result of a recent trial on the Thames of a little petrol boat which developed a speed considerably in excess of any other vessel of equal length the means of propulsion of seagoing vessels and the lines on which they are built may undergo radical changes in the next few years. Its inventor, working on the theory that the power exerted by engines were better devoted to supporting the boat on the surface than to pushing it through the water, after numerous experiments with differently shaped, full sized models, designed a petrol boat with a practically flat bottom. The gain in lightness of engine and fuel by the substitution of the internal combustion petrol engine for steam enabled a forty-foot boat to attain a speed of twenty-six knots, and the inventor estimates that a 220-foot destroyer with petrol engines would reach a speed of forty-five knots. The perfection of the internal combustion engine, enabling larger sizes to be used successfully at sea, remains to be accomplished, but the physical and mechanical difficulties to be overcome hold out sufficient rewards to awaken energetic, studious effort.

The Russian government has ordered a project drawn up for the construction of a canal to connect the Volga with the Caspian sea, and to be cut quite independent of the river's delta. Regular navigation is made difficult by the low water in the delta, and the development of Russia's trade with the countries of southwest Asia is greatly impeded. The estimated cost of the big work is $6,500,000, but its execution will depend on the closing of the war.

We are planning to have a big issue for July. You can help by sending in some item of interest and by telling your friends about it.

If you know a person interested in drafting who has never seen a copy of this magazine, we will send you a present for his name, or better still, have him send 10 cents for a copy of the July issue. It will pay him.

The First Victim of the Heat.

Mr. Richard Koehler, a draftsman, residing at 140 Van Ness avenue, Cleveland, Ohio, was overcome by heat on April 9th. He was walking down Superior street and was suddenly overcome and when falling struck his head heavily on the side of the walk. He received a concussion of the brain and several scalp wounds. He was carried to the Huron Street Hospital.

Willson's Gummed Letters for Drawings and Tracings.

An inquiry has been received relative to the use of stencils and gummed letters for maps, drawings, tracings, etc. Upon investigation we find the Willson Gummed Letters, made by The Tablet & Ticket Co., 87 Franklin street, Chicago, and 381 Broadway, New York, will be neat ones for use. The illustrations are from their catalogue.

Gummed figures are for sale in a number of the stores but these are printed on a piece of paper which, if put on a tracing, would produce a light square on the blue print, but the individual figures would work all right.

Where a large title is desired and the blue print is to be neatly made, then it is better to get separate letters and figures and paste them on.

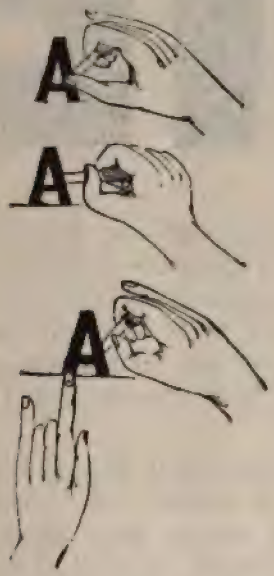
These can be obtained either white, black or red, but that feature need not enter into the case unless the white letter would not be opaque.

Perhaps it would be better to get either black or red. Letters and figures of several styles and sizes can be obtained, the limits in size being here shown. First lay out in a line the letters you are going to put on. This will give you some idea of the length and the spacing required.

In the case of a tracing, rub several guide lines on the drawing under the place where the letters are to be and set them along the tracing to this line.

Nothing is better than a small pocket knife to handle the letters conveniently.

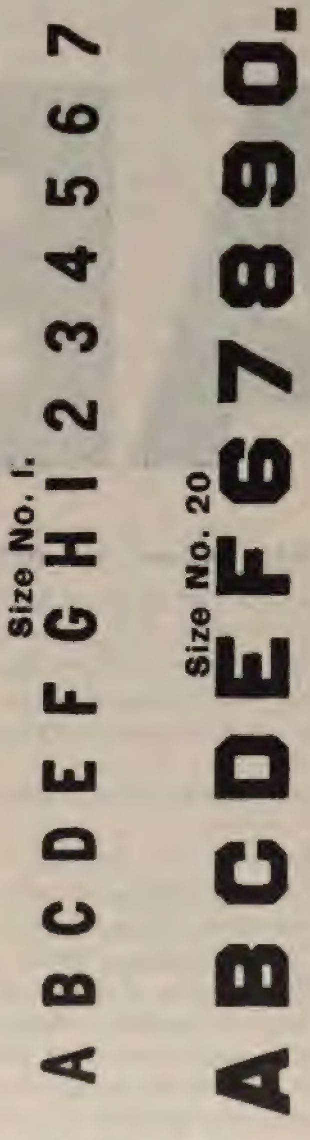
Pick up the letter between the thumb and blade thus:



Then moisten it as you would a postage stamp, but very slightly, keeping the letter all the time firmly between your thumb and the blade; now by moving the letter a hair's breadth on the blade, it will adhere to it, and you can see clearly to place the letter straight and square on the line, then place the forefinger of the left hand on the letter as shown.

Remove the knife and press the letter gently to its place. You need not rub it down until your line is finished, then place a blotter or paper over the whole line and rub down well with the handle of the knife.

When a great amount of lettering is to be done, a wet pad will be found useful, the best for this purpose is a small piece



of chamois, about 3 or 4 inches square.

Wet it thoroughly and lay it on a piece of glass. This will be found very convenient and much better than a cloth or sponge, as it does not take the gum off the letters.

Remember, if you want a neat job, use very little moisture, but see that the entire surface of the gummed side is slightly moistened, and rub it down well so as to exclude every particle of air.

and Machine Design adapted to the preparation of the students.

4. *Materials of Construction, Fuels and Lubricants.*—Lectures on the properties of materials accompanied by laboratory tests; lectures on fuels and lubricants with laboratory tests on the heating value of coals and efficiency of lubricants.

5. *Shop Work.*—Practice with hand tools, wood and metal working machinery, and in blacksmithing and pattern-making.

The instructional force is taken from the regular faculty of the College of Engineering and the entire laboratory and shop equipment belonging to the college is used by the students in the Summer School.

The requirements for admission do not extend beyond a working knowledge of English and Arithmetic, but the policy is to allow a large amount of individual work so that the student may take advantage of all the preparation he has obtained.

This school offers to those unable to take a regular four-year course an opportunity of obtaining working knowledge of the methods of testing and the use of

Size No. 26.

AB12

Summer School for Artisans.

The fifth annual session of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 26th and continues for a period of six weeks.

Courses of study are offered in the following subjects:

1. *Engines and Boilers.*—Lectures and Laboratory courses, covering the theory, construction, management and testing of Steam Engines, Boilers, Gas Engines, Refrigerating Machines, etc.

2. *Applied Electricity.*—Lectures and Laboratory courses, covering the theory of direct and alternating current dynamos and motors, the operation and method of testing electrical machinery, batteries, transformers and other apparatus, photometry and calibration of instruments.

3. *Mechanical Drawing and Machine Design.*—Elements of applied Mathematics, courses in Mechanical Drawing

instruments, together with such theoretical principles in each case as the nature of the subject and the preparation of the student may permit.

Correspondence students have found this school of value in giving an opportunity for laboratory practice along lines in which they have had theoretical instruction.

A bulletin describing the work of the School for Artisans in detail will be sent on application to

Frederick E. Turneaure,
Dean College of Engineering,
Madison, Wis.

Lehigh University Register.

The Register of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 630 students from 24 states and 8 foreign countries, the largest in the history of the institution. There are 56 in the teaching staff.

Thirteen four-year courses of instruction are offered at the University: the Classical Course, the Latin-Scientific Course, the courses in Civil, Mechanical, Marine, Metallurgical, Mining, Electrical and Chemical Engineering, Analytical Chemistry, Geology, Physics and Electrometallurgy.

A list of graduates of the University, with their present occupations, 1,399 in number, during the 39 years of its existence, indicates that this institution is exerting a marked influence on the industrial development of the United States and of foreign countries.

Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

The Automobile Pocket Book, by E. W. Roberts, M. E., size 3¼x5¼, 320 pages Limp leather backs, price $1.50. The Gas Engine Publishing Company, Cincinnati O.

A compendium of the gasoline automobile, for use of operator and designer

The book gives clear and concise information on the operation and care of an automobile, telling what to do in case of emergency and containing much matter of an educational character.

This book does not take up the historical side of the subject but the author goes right into the practical work to give the desired information.

The book is not an exponent of any particular make of machine or appliance and does not take up the matter with a great flow of technical terms and higher mathematics.

The illustrations were especially prepared for this book and have received very careful attention.

How to Resign.

"Going to resign, are you?" said the superintendent to an indignant person who had been pouring his grief into his ears. "Can't stand it another minute, eh? Put up with it as long as you could, and now you're going to throw up your job and tell your chief what you think of him? Yes, I know. Last straw and all that sort of thing? Uh-huh.

"Did you ever see my set of rules for resigning? I framed them up years ago when I was in the newspaper business, and I have used them ever since. I have resigned often since then, always in the way prescribed by these rules. Perhaps they will be of service to you. Here they are:

"Rule 1. After receiving the last straw don't do anything for two hours. Above all, don't write anything.

"Rule 2. At the expiration of two hours, write your resignation, and make it as hot as you can. Relieve your feelings and say everything you have been

penning up in our breast. Scorch the scoundrel.

"Rule 3. Then go home.

"Rule 4. The next morning, immediately upon arising, read over your resignation, and tear it up.

"Rule 5. Go to work at the usual hour.

"Take a copy of them," concluded the superintendent, "and you will find that they are absolutely essential to any man who expects to resign frequently and still continue to rise in the world."—*"Popular Mechanics."*

Test Wine by Telephone.

One may well ask if the telephone has developed a conscience in connection with the discovery by Maneuvrier, the well-known French chemist, of a means of detecting by its aid the adulteration of wines. In the method he has perfected two glasses, one filled with the wine to be tested and the other with a like quantity of wine known to be pure, are placed on an apparatus resembling a scale and telephonic connection is made with both liquids. If both wines are pure no sound is heard in the receiver; but if one contains water or other liquids or solids a noise is produced until a pointer moves to a given place on a dial plate. This movement renders the conductivity of the liquids uniform and the gradation on the dial where the pointer stops shows the extent to which the wine has been adulterated.

Every man should have his own tools; his use of them determines his degree of success.

A cracked bell does not ring because of the grating of the two broken surfaces on each other, but if these could be trimmed off by means of a saw or file, it would remedy the defect.

The Draftsman's Scale.

BY PROF. A. EDWARD RHODES.

[COPYRIGHTED.]

Scales are used for obtaining the various measurements on drawings. They are made in several forms. Those most used are the triangular scale and the flat scale with beveled edges.

The graduations are arranged so that the drawings may be made in any desired proportion to the actual size of the object. For mechanical drawings the proportions usually are full size, half size, quarter size and eighth size. If a drawing is quarter size, 3 inches space on the drawing represents one foot on the object. Hence, a scale to be proportional must have 3 inches of its length so divided as to represent proportional inches and fractions thereof. To this end, 3 inches on the scale is divided into 12 equal parts, each part representing one inch. These inch parts are then subdivided into quarters, or eighths, as desired, and are read quarters or eighths, same as like measures (divisions) would read on an ordinary rule.

Figure 1 shows a full sized drawing of a six-inch flat scale having 3 inches to one foot, and 1½ inches to one foot graduation on it to read to quarter inches.

The lines A, B, C and D, if measured by the quarter size (3" graduations) scale, would read 18 inches, 14½ inches, 12¾ inches and 8¼ inches. If measured by the eighth size (1½ inch graduations) they would read just twice as long, viz.: 3'—0", 2'—5", 2'—1½", and 16½".

by the 1½"=12" scale would read 7¾

The lines E, F, G and H, if measured inches, 15 inches, 2 feet 6½ inches, and 3 feet 10 inches, and contrawise if measured by the 3"=12" scale would read only half as much, or 3⅞", 7½", 15¼" and 23".

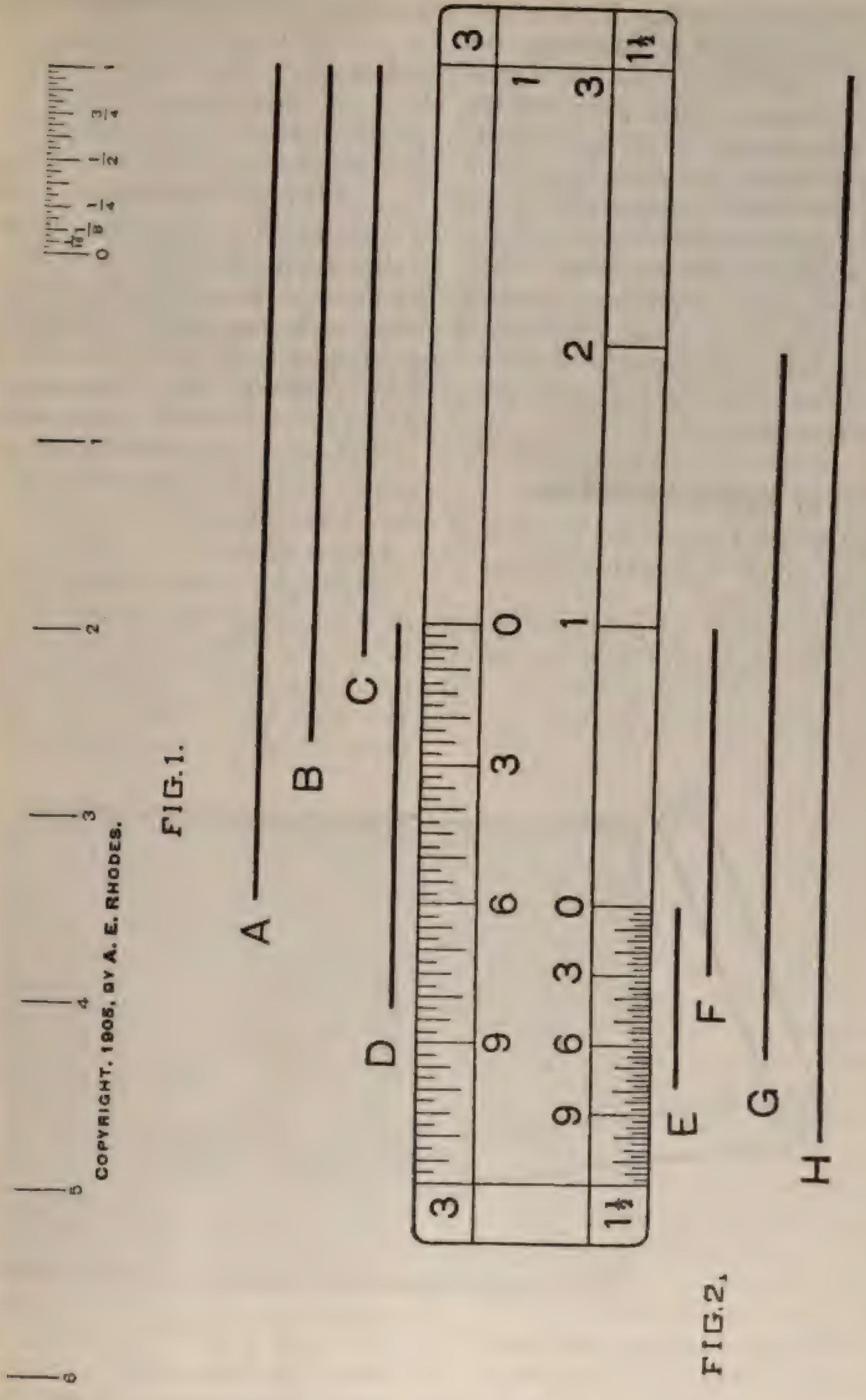


FIG. 1.

FIG. 2.

The Draftsman's Scale.

For full size drawings I use a scale like Figure 2. It is 12 inches long and only has one inch, the end one, divided into fractions of an inch. Originally this scale was designed for my classes in the grammar grades, as I found they experienced considerable trouble and wasted much valuable time finding the various division marks on the scale. These scales are made by glueing a carefully printed strip of paper on a bevel-edged ruler and then covering paper and wood with a coat of shellac, to keep the paper from becoming soiled.

For Rapid Sketching.

Many a good idea is lost for lack of time and proper facilities for reducing it to practical form.

For this reason we think that many men will be interested in a new device which reduces the time required, and otherwise greatly facilitates this class of work.

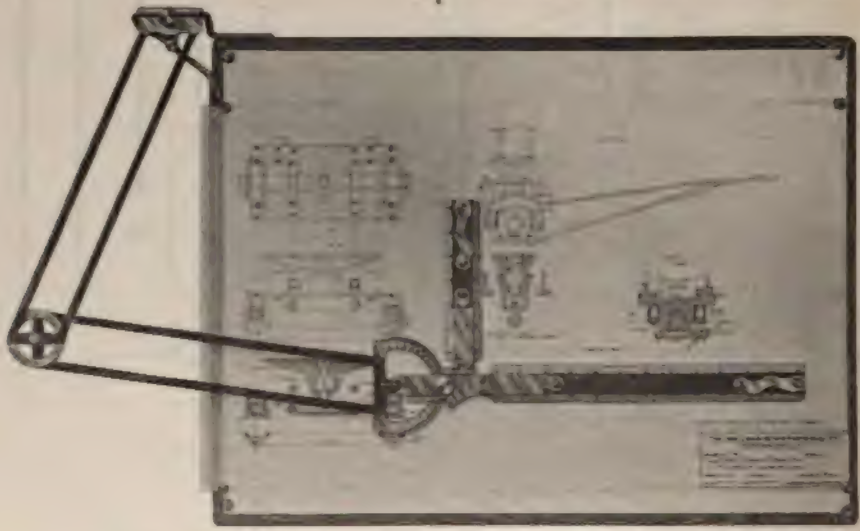
The Rapid Sketching Device is a very complete and simple arrangement for just this very purpose. It makes all angular work as readily executed as straight work, and permits you to draw your lines just the exact length required (a very large saving in time).

Take the simple case of drawing two lines of a certain length at right angles. Ordinary means require twelve distinct operations to do this. The Rapid Sketching Device requires but two.

And this is not all of the difference. This device is complete in itself and you do not have a lot of loose tools lying about in the way, and as it is fastened to the drawing board it does not have to be held in position, and is not continually falling off. The mind is thus left free to think about the subject matter of the sketch, resulting in a better design and more rapid progress.

How It Works:

Two scales fit into chucks (making them interchangeable) in such a manner as to form a square, and a protractor permits this square to be set at any angle, and when thus set the square may be moved anywhere about the board, and it



will always lie parallel to its previous position. By using two scales of the same kind forming a square instead of having only one scale, no matter what angle is required, the other scale gives the lines

[illegible]

[illegible] Beginning with the fall of 190[illegible] [illegible] will undertake to prepare teachers of Manual Training and [illegible]

[illegible] School of Manual Training and [illegible]

[illegible]

Civil Service Examinations.

The U. S. Civil Service Commission an examination June 7, 1905, to secure eligibles for the positions of artist draftsman at $1,200 per year and marine fireman at $540 per year. Applications should be made to the United States Civil Service Commission, Washington, D. C. In applying the exact title as given in this notice should be used.

Millions in the Ocean.

Washington, April 10.—If Sir Wm. Ramsay, professor of chemistry in University College, London, officer of the French Legion of Honor, and member of scientific and philosophical societies in nearly every civilized country on the face of the globe, has figured things out correctly, there ought to be about $2,400,000,000,000 in the Atlantic ocean for him. Gold is known to exist in a state of solution in the sea, and a new process has been invented to extract it. Sir Wm. Ramsay is said to have given the new scheme his sanction, says Frank W. Mahin, United States consul at Nottingham, England, in a recent report on the subject.

A syndicate has taken up the matter, and experiments which began 40 years ago, and which showed that gold is dissolved in sea water to the amount of about a grain per ton of water, are about to be resumed. According to the calculations of the scientifics, a grain of gold being worth 4 cents, and the tons of water in the ocean being placed at 60,000,000,000,000, there ought to be $2,400,000,000,000 in it for the syndicate in due time.

If the new process should do all that its friends sanguinely claim for it, gold would become a drug on the market; but it is considerably remarked—perhaps that the stock market may not be too actively affected—that "it would obviously not serve the interests of the syndicate to secure gold in greater quantities than the market could absorb."

The Cement Engineer.

With the many uses to which cement, either plain or in concrete, is being applied there comes a demand for men specially posted in this class of work. Nearly every number of our engineering papers have articles on the subject of "Cement and Its Uses." From the day the Pantheon in Rome was built to this day there has been much confidence in buildings of cement.

While there is a general belief in cement, yet there is not a great fund of knowledge on the subject and the cement engineer will have to depend on current literature and his experience.

The cement used by the Romans and other ancient people was what is technically known as natural or hydraulic cement made from natural cement ground and burned.

That has been succeeded commercially by Portland cement, which has been on the market since 1855 when the first plant was established in Germany, and for thirty years was made in that country alone.

Then it was introduced into this country to a limited extent, probably 85,000 barrels per year, but in 1904 it has been estimated that there was 22,000,000 barrels made. This shows the wonderful growth of this industry and the use of cement is now in nearly every part of building operations.

The young man desiring to take up this work will find an uncrowded field and lots of work.

If you have an article that has merit it should be known to all readers that need it, not to a few.

Devoted to Drafting, Illustrating and Home Study.
PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Cast Metals.

THE more important cast metals used in machine construction are cast iron, malleable cast iron cast steel, brass, bronze, gun metal, aluminum, lead, tin, zinc and Babbitt's metal.

Castings for machine parts are made by pouring molten metal into moulds which are previously formed by patterns in sand in the foundry. Cast iron and plaster moulds are often used for the lighter metals, such as lead, zinc, etc.

The chilling effect of the surface of the mould on the metal produces a skin on the casting, this skin being harder or softer, depending on the character of the mould.

It has been found that by varying the composition of the metal and by making the surface of the mould of a material that carries off the heat quickly, a hard surface is produced which if of iron is called *chilled* cast iron.

Metal moulds are used to produce this effect on car wheels, etc.

Cast metals form in a crystaline manner in cooling, these crystals arranging themselves in lines perpendicular to the surface, hence when two surfaces come together at an angle, the crystals do not unite but leave an open or weak spot.

By filling in the corners of patterns and rounding the sharp edges a stronger and more perfect casting is obtained.

To avoid irregular internal strains in castings when cooling, it is necessary that the section be made as uniformly as possible.

All metals or combinations of metals shrink or expand while cooling, and to allow for this the pattern must be made to permit these changes either by an addition or subtraction to the pattern over the size desired in the required casting.

The patternmaker uses a special rule called a "shrink-rule" for measuring patterns; it would be a certain amount per foot longer than a standard rule, depending on the metal used in the mould made from the pattern.

TABLE OF SHRINKAGES.

Name.	Amt. per Ft.
Cast Iron	1/8
Brass	3-16
Steel	1/4
Malleable Iron	1/8
Zinc	5-16
Tin	1-12
Aluminum	3-16

This is for castings where the thickness runs about one inch and cast under ordinary circumstances.

Thicker castings less and thinner more than the above amounts.

There are white cast iron and gray cast iron castings used in machine construction, the former being very hard and brittle, the latter being softer and hence weaker.

Carbon, one of the substances in the casting, is more fully combined with iron in white, while in the gray it is not taken up so well but shows as graphite crystals.

Malleable castings are made by putting a gray-iron casting in a suitable box and covering it with powdered red hematite (iron ore) and heating to a bright red color for a period of two to thirty hours, depending on the size of the casting.

Such castings are thus made tough and strong but cannot be welded though they may be worked to a certain extent like wrought iron.

Cast steel is made by melting pieces of blister steel in a closed crucible and casting into moulds.

Brass and bronze, Babbitt-metal and gun metal are made by adding tin, zinc or lead or all of them to copper, the latter metal being always in excess.

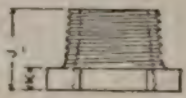
Brass is used for an endless variety of articles and where greater.

Bushed Fittings.

Fittings for pipe can be secured reducing in a great variety of sizes, but in order to avoid cost of the "extra" size, a piece called a "bushing" is used. The bushings may be obtained in a large number of sizes and either concentric or eccentric, that is, with the outlet on a line with the center or below the center.

An eccentric bushing enables better drainage, especially where one pipe is much larger than the other.

The nut (K) is usually hexagon (6 sides) and might be considered as an ordinary nut on a bolt, the distance across flats equal to twice the outside diameter of the pipe.



On smaller sizes K is $\frac{1}{4}''$ while on larger ones like 10 and 12 inch, it would be $1\frac{1}{4}''$. The length of thread is what is usually put on a pipe of the different sizes.

The Advantage of Fillets.

Cast iron, when it congeals on cooling, forms in a crystalline manner with the lines of the particles perpendicular to the surface.

When two surfaces come together at right angles, as in Fig. 1, the line of the crystals butt into each other, but do not join, thereby leaving a weak place, as at a and along the line b c.

If the surface was the shape of the cross-section, as shown in Fig. 2, these lines have no abrupt change in direction, so that no poor formation would take place.

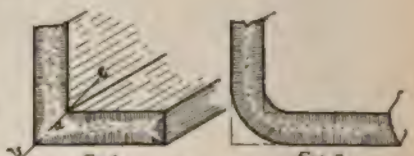


Fig. 1 Fig. 2

To accomplish this in castings the pattern is filled up in the corners and rounded on the points. The filling of the corners is called filleting and these fillets are made of wax, wood, leather or soft metal. The leather fillet is cut of the as shown in No. 6, the hair side of the hide being on the straight side. On the other side will be seen the fillet applied; that is pressed into shape.

There are several advantages in using the leather fillets, the main one being its

flexibility, which permits it being pressed into corners not quite at right angles and when well applied with glue gives good results if the excessive glue is carefully

cleaned off.

Glue on patterns when exposed has a tendency to hold the sand and cause a rough casting.

Dimensioning Drawings.

A writer in the American Machinist, in discussing the "Dimensions on Drawings," says that he thinks the whole question depends more upon shop system than anything else.

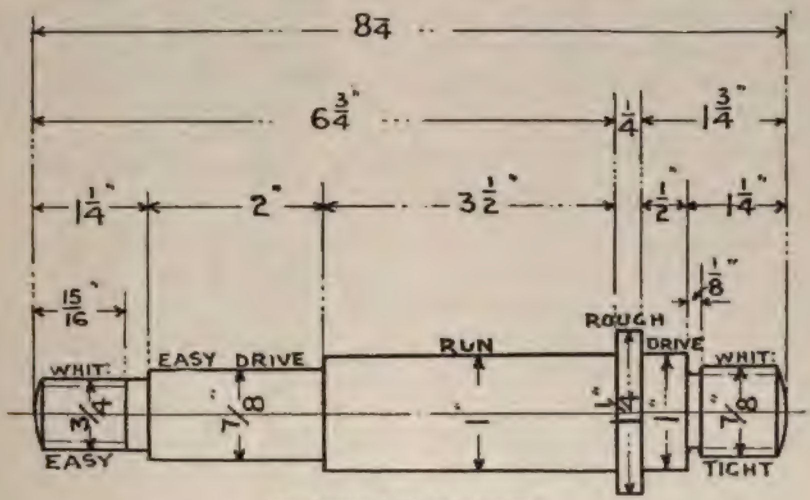
or, on the other hand, that he can use that allowance + .00025 inch. If such is the case, then well and good. That is one system."

Another writer suggests that the foreman put the workman right as to what allowance should be made for fits.

Why not mark the drawing, "fit to suit" and let the workman put it in to "suit the fit."

"That is not the best practise by a long way, as what will the foreman do if he cannot get hold of the drawing or other parts showing how the stud is to be fitted in position? We cannot tell what allowance is required any more than can the workman. For small jobbing shops that arrangement might do, but when time is valuable and 'output' considerable, other methods must be devised."

"Where interchangeability is worked for and tools are periodically examined



DIMENSIONS ON DRAWINGS

"We will take Mr. Fish's method first: It is necessary for the man in the shop to understand that the allowance made for fits as given on his sketch need not be absolutely adhered to. Probably the man knows that he can work within, say, .0005 inch of that allowance, but not exceed it,

and kept within standard limits, it is only necessary for the draftsman to mark the various diameters on his drawing, as 'running' or 'easy drive,' 'push,' or 'driving fits,' as the case may be. For nearly all cases these notations suffice to cover the range of accuracy required.

"Where this system is prevalent, the turner will know exactly what limits to work to, or how much to leave on if the piece is to be ground. The holes will be reamed to standard limit gages to receive the stud, and the parts will be ready for assembling without undue waste of time in any way.

"Where the work is of a more exacting nature, the draftsman should, of course, dimension his drawing accordingly, but for ordinary work this system will be found consistent with good shop practice."

We believe that the practice in the particular shop in which the draftsman is employed should govern the way to dimension such work.

We hope there are no draftsmen who will not get in with the superintendents and foremen and do it their way.

This should not be taken as indicating that the shop should boss the drafting room or the reverse, but that the two should work in harmony so that the foremen will understand the picture language of the pencil pushers.

Record of a Garbage Reduction Plant.

To collect and reduce the garbage of the city of Cleveland cost $9,268 for the month of March, 1905. In that month $2,219 was paid for three new digesters, part of the painting of the wagons and boxes. The wagons go about on regular routes and collect the garbage, which is taken to a depot and loaded on cars and transported to the plant.

During March 4,070,000 pounds of garbage was collected, an increase of 744,000 pounds over last year.

Out of the garbage was extracted 129,675 pounds of grease, which is 23,675 pounds more than last year.

Before the city purchased the plant it was paid about $60,000 a year by the reduction company for the privilege of collecting garbage in the city.

Machine Shop Philosophy.

JOE CONE.

System is just as essential in the machine room as in Wall street.

A junk shop is all right in its place, but its place isn't in a machine room.

The fellow who kills his employer's time at the same time kills his own opportunity.

Nobody but a 'prentice boy and a lazy mechanic will stand at a vise and pound cold iron.

Many a man loses a good job by continually looking round to see if the boss sees him working.

It's a notorious fact that 9 out of 10 unsuccessful machinists believe that they can make farming pay.

New Method of Bending Pipe.

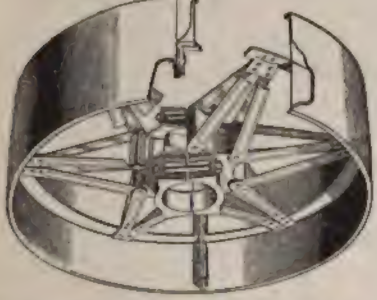
Great improvement over the old method of bending sand filled pipe by hand is promised by the invention of a new bending machine by means of which one man can bend a piece of two-inch pipe into an "S" in three minutes. The machine is operated by a hand wheel carrying a pinion, the latter engaging a quadrant gear, which in turn operates the bending quadrant. The pipe to be bent is held in position at one end by a "U" shaped clip, while a pin or roller placed in a platen engages the other end. Placing the pin in different holes in the platen governs the curvature obtained. While the machine is portable, its chief value will be to those shops where a large amount of tubing is bent.

Phillips Pressed Steel Pulleys.

The Philips' Pressed Steel Pulley Works, of Philadelphia, Pa., have recently placed on the market their design of pressed steel split pulleys guaranteed for double belt duty. The pulleys range in size from 12" to 36" diameter, 3" to 12" straight and crown face. This line will be shortly increased to pulleys 60" diameter.

The design represents latest developments in pulley construction and received highest award at the World's Fair, St. Louis, Mo., 1904.

The rim is a single piece of steel pressed double thickness, presenting to the belt a surface free from break in its entire width, with nicely rounded edges.

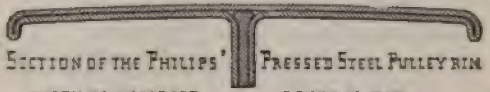


The centre rib of the rim is reinforced with a steel section of special design and of different size for different widths of pulleys. This valuable feature permits of giving unlimited strength to that part of the pulley where all transmission of power takes place, without unnecessarily increasing the weight of the rim.

Rim lugs and bolts securing the pulley halves together extend over entire width of face making this point of rim strongest. Channel plates fitted on head end of bolts prevent same from turning when pulley is being placed on shaft.

A spoke and rim interlocking plate transmits the power from the spider to the rim. Shearing at this point is distributed over six rivets with an almost entire absence of shearing strain at the rim rivets.

Hub and spoke are also interlocked and by countersinking material of spoke deep into hub, any tendency to shear at this point is prevented. This connection is also riveted.



SECTION OF THE PHILIPS' PRESSED STEEL PULLEY RIM WITH RE-ENFORCED CENTRAL RIB.

The hub and bushings are gray iron castings; bushings fitted with projections preventing any independent movement.

Four hub bolts secure pulley to shaft. Set screws or keyway furnished if desired.

The spoke is a conventionalized cantilever beam, with the material immediately surrounding its neutral axis removed, this section of the beam not being under great strain. With maximum load, extreme fibre stress on material of spoke at hub will not exceed 1,000 lbs. per square inch —a very high factor of safety.

The spoke is spread transversely at section next hub, taking care of all transverse strains.

Ferdinand Philips, M. E., inventor.

A varnish of melted sugar applied with a soft brush is the novel protective coating for butter that is finding favor in Germany and England.

A new two-seated motor car recently tested in England is fitted with a battery of forty-eight cells with a capacity of 240 ampere hours, the weight of the cells in crates being 1,400 pounds and of the car complete 3,000. Tests show the watt hours of discharge per pound of cell to be about fourteen, and on a run from London to Bath, 108 miles, on one charge the voltage at the commencement was 108 and 92 at the finish, the average speed being thirteen and a half miles an hour.

ELECTRICAL.

Room at the Top.

THE New York *Commercial* has recently given some interesting facts and figures relative to the scarcity in the field of electricity of competent engineers and other workers, and the brilliant opportunities existing today of reaching the top in that peculiar field called the "commercial end" of electricity. The article referred to, after divesting it of some unimportant data, goes on to say:

"A few years more will see the development of a third and better prepared generation of electrical experts, and it is safe to say that they will be the result of a combination of a practical training, thoroughly mixed with a theoretical education."

This authority admits that much of the knowledge in the field today has been acquired in the school of "hard knocks," yet out of 100 men who are at the top of the electrical engineer's art in Chicago at this time, he has prepared a striking list bearing on their ages and their salaries.

The average age of these men is 33½ years, the extremes running from 27 years to 48 years, and indicating that the business is in charge of young men. At 33 years old the young man is worth $3,178 a year, increasing until at 38 years old the average salary is $4,000. In groups, five of the 100 men have salaries of more than $10,000 a year; nine have incomes between $5,000 and $10,000; 66 have incomes between $2,400 and $5,000, and two have incomes under $2,000. To these 100 men selected the tabulator says that at least 100 more in Chicago should be added who will average quite as high, thus giving 200 men to Chicago in electrical engineering with salaries averaging $3,440 annually.

An interesting classification has been made of these first 100 men, showing their lines of endeavor. For instance, it is shown that seven salesman in the business average within $100 a year of the editors and professors. This table shows:

	No. of Men.	Aver. Age.	Aver. Income.
Salesmen	7	33	$2,400
Sales managers	12	26	3,400
Business men	10	36	4,800
Sales engineers	8	25	2,150
Electrical engineers	16	33	2,500
Electrical experts	8	33	2,200
Constructing engineers	6	33	2,350
Operating engineers	3	32	3,250
Operating managers and superintendents	10	34	3,750
Professors and editors	6	34	2,300
Patent attorneys	4	32	4,000
Consulting engineers	9	40	5,400

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leaves the armature. With the car drawing the current down through the trolley, the core armature is drawn from plate No. 1 to plate No. 2, and the current passes from the armature to magnet No. 1 and the switch is turned. The magnets are located in the box at the side of the switch in the street, and are fully protected from dust and water. They pull the switch point as is desired.

Air Resistance to Car Fronts.

The electric railway test commission appointed by the authorities of the Louisiana Purchase Exposition early in 1904 to conduct special investigations into the unsolved problems of electric railroading is now completing its field work by making tests of the air resistance to the motion of different shapes of car fronts at all the speeds reached by interurban lines up to seventy miles an hour, the limit set by the line and motor capacities of the Indiana Traction Company, where the experiments are being conducted. A special dynamometer car by which the total air resistance and its several complements may be measured has been constructed. It consists of a steel flat car with an independent car body, which can roll freely on rails screwed to the flat car floor. To further determine the several resistances of the main portions and vestibules of the car body these are separately mounted and connected to separate dynamometers. The pressure of the air upon the body is measured by scale beams especially constructed for the tests, and in order to eliminate all forces but those due to the air the controllers and trolley are mounted on the flat car body. To determine the varying speeds the test track has been divided into sections of 1,000 feet marked by large signs, and a voltmeter, the readings of which are directly proportional to the speed, will also be used.

Electric Plant in Formosa.

United States Consul Fisher, writing from Tamsui, Formosa, states that, in the early part of 1904, the engineering department of the Formosan government commenced work on the construction of an electric plant on the upper course of the river Shinten, about ten miles to the southeast of Taihoku. Water power will be used, and will be supplied by a canal cut from the upper course of the south branch of the Nansei river, which flows down the mountains in a series of cascades. The length of the canal is 7,200 feet. The width of the canal at the bottom is from eleven to twelve feet, and the discharge will be 250 cubic feet per second. This is intended to give 1,000 horse-power, but 650 horse-power will be sufficient for the present requirements.

The plant will be equipped with two McCormick turbines, each 384 horse-power and 450 revolutions per minute; two three-phase Westinghouse alternating current generators of 250 kilowatts capacity, at 11,000 volts and 450 revolutions per minute; and a McCormick exciter turbine of forty-nine horse-power, together with a Lombard governor. The plant will supply current for lighting the cities of Taihoku and Tamsui, and also for an ice plant, sawmill and other works in the first-mentioned city. The cost, including the construction of the canal, will be approximately $175,000.

Danger from a dangling broken trolley wire is removed by a safety device for the protection of persons from the electric current just placed on the market. The device, consisting of an ordinary connecting ear, is fitted to each section of wire and held in proper position by the strain on the trolley wire. If this tension is released as by the breaking of the wire, the current is immediately cut off the broken section.

Motor Fire Apparatus

Turn Out To Electricity

STRUCTURAL.

Standard Specifications.

IN order to have a knowledge of good forms, it is well to study what has been done along the line in question. This may be said of specifications. The following shows, not only the wording necessary, but the arrangement as well and this size type, 10 point, as it is called, is about the proper face to use.

The paper should be of good material, not too heavy, and cut in sheets 8x13, with a red line 1¼" from the left-hand long edge and ¼" from the right. No lines are shown here.

The cover paper should be 8½x14, folded over and stapled at the top. A total distance of 2¼" should be allowed at the top for the name and address of the firm.

All the blank places are to be filled by printing in the name of the firm at the head of the specifications who is going to do the work. Other sections will be given in future issues of this magazine.

STANDARD SPECIFICATIONS

—FOR—

BUILDINGS. BRIDGES, FRAMEWORK, MACHINERY, ETC.

GENERAL CONDITIONS.

1. General Specifications.

Attached to and forming a part of this specification, is a general or descriptive specification setting forth the construction of the particular piece of work for which proposals are asked, the intention being to embody in the general specification a description of the work only and to apply to the construction of such work all the clauses of these Standard Specifications which properly relate to the same.

2. Drawings.

The work is to be executed in strict accordance with the drawings prepared and furnished for same by................, and no deviations are to be made from the constructions shown on such drawings without the written consent of...............

3. Proposals.

Proposals for the work are to be sent as per the accompanying form.

4. Return of Drawings.

The drawings and specifications sent out for estimating purposes are to be returned with the proposal for the work, otherwise the proposal will not be considered. At the conclusion of the work under any contract, all working drawings and specifications shall be returned to................

5. Inspection.

All material and workmanship will be subject to inspection during the various processes of manufacture, and access must be permitted for................, or their representative, at any works where the material is in process of manufacture. A sufficient length of time before the performance of any piece of work, notice must be given.................to allow their representative to arrive at the place of manufacture.

The acceptance of any material during the process of manufacture will not prevent its rejection if afterwards found defective.

6. Risks.

The contractor will assume all risks from floods, storms, damage to personal property, casualties of other descriptions, and will furnish all material, tools, machinery, and labor incidental to or in any way connected with the manufacture, transportation, erection, or maintenance of the structure, until its final acceptance, unless otherwise specified.

7. Finishing Work.

The contractor must remove all false work, rubbish and other useless material caused by his operations, at his own expense before the work is finally accepted.

STRUCTURAL IRON AND STEEL.

1. Structural Steel.

The steel material throughout will be of the Open-Hearth manufacture; Bessemer steel not to be used unless definitely agreed upon. It will be of three grades: rivet, soft, and medium.

Rivet Steel will have an ultimate strength of 48,000 to 58,000 lbs. per square inch. Elastic limit, not less than one-half the ultimate strength. Elongation, 26 per cent. Bending test, 180 degrees flat on itself, without fracture on outside of bent portion.

Soft Steel will have an ultimate strength of 52,000 to 62,000 lbs. per square inch. Elastic limit, not less than one-half the ultimate strength. Elongation, 25 per cent. Bending test, 180 degrees flat on itself, without fracture on outside of bent portion.

Medium Steel will have an ultimate strength of 60,000 to 70,000 lbs. per square inch. Elastic limit, not less than one-half

the ultimate strength. Elongation, 22 per cent. Bending test, 180 degrees to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

9. Pin Steel.

Pins made from either of the above-mentioned grades of steel will, on a specimen test-piece, cut at a depth of 1 inch from surface of finished material, fill the physical requirements of the grade of steel from which they are rolled for ultimate strength, elastic limit, and bending; but the required elongation will be decreased 5 per cent.

10. Eye Bar Steel.

Eye Bar material 1½ inches and less in thickness made of either of the above-mentioned grades of steel will, on test-pieces cut from finished material, fill the requirements of the grade of steel from which it is rolled. For thicknesses greater than 1½ inches there will be allowed a reduction in percentage of elongation of 1 per cent for each ⅛ inch increase in thickness to a minimum of 20 per cent for medium steel and 22 per cent for soft steel.

11. Sheet Steel.

Sheet Steel for corrugating purposes is to be rolled full gauge of the thickness specified, and to be made of the quality specified for Medium Steel. When galvanized corrugated steel is required, the galvanizing will be done after the steel is corrugated, and not before.

12. Steel Castings.

Steel Castings will be made of tough metal and have an ultimate strength and chemical analysis best adapted to their requirements.

13. Iron Castings.

Except when chilled iron is specified, all castings will be tough gray iron, free from injurious cold shuts or blow holes, true to pattern, and of a workmanlike finish. Sample pieces 1 inch square, cast from the same heat of metal in sand molds, will be capable of sustaining on a clear span of 4 feet 8 inches a central load of 500 lbs. when tested in the rough bar.

14. Variation in Weight.

For rolled plates a variation in cross section or weight of more than 2½ per cent from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations: Plates 12½ lbs. per square foot or heavier when ordered to weight, will not average more than 2½ per cent variation above or 2½ per cent below the theoretical weight.

Plates under 12½ lbs. per square foot, when ordered by weight, will not average a greater variation than the following:

Up to 75 inches wide $2\frac{1}{2}$ per cent above, or $2\frac{1}{2}$ per cent below the theoretical weight; 75 inches and over 5 per cent above, or 5 per cent below the theoretical weight.

15. Finished Weight. When the terms of the contract for any piece of structural steel or iron work are at a certain rate per pound, payment will be made on the actual shipping weights of the finished material and not on the material as ordered from the mill.

16. Weighing. All steel and iron work is to be carefully and accurately weighed and exact reports of same promptly forwarded to ....

17. Workmanship. The workmanship throughout to be strictly first-class in every respect, and done to the satisfaction and approval of .... All parts of the metal work exposed to view will be neatly finished and all idle corners of plates and angles will be neatly chamfered off, unless otherwise specified, even if they are not so shown on the drawing.

18. Milling. The ends of all columns and the ends of crane girders and other members, where shown, will be faced off square and true to the exact lines and angles shown on the drawings. All abutting ends at splices of the component parts of compression members are to be milled and drawn up to a perfect bearing.

19. Rivet Spacing. Rivets will not be spaced less than three times the diameter of the rivet in any case, and in the cover plates of compression members never greater than 6 inches, or 16 times the thickness of the plate. They will not be spaced less than 1 2-3 diameters of the rivets from the ends of rolled steel, or $1\frac{1}{2}$ diameters from the edge of plates or angles.

20. Reaming. Where reaming of holes is required it will be marked on the drawings, and in such cases the holes are to be punched $\frac{1}{8}$ inch less diameter than the finished hole, and the hole reamed so that 1-16 inch of material is taken out on each side of the hole.

21. Counter-sinking. Where counter-sinking is required it will be shown on the drawings, and where the sharp edges of reamed holes are required to be removed it will also be indicated on the drawings.

22. Riveting. Wherever practicable, all shop rivets will be machine-driven with powerful machines capable of closing up the plates and holding them in forcible contact while the rivet is being driven and set. Field riveting will be done with heavy hammers and button sets. Any loose or defective rivets will be cut out and replaced with perfect ones.

(Continued in July number.)

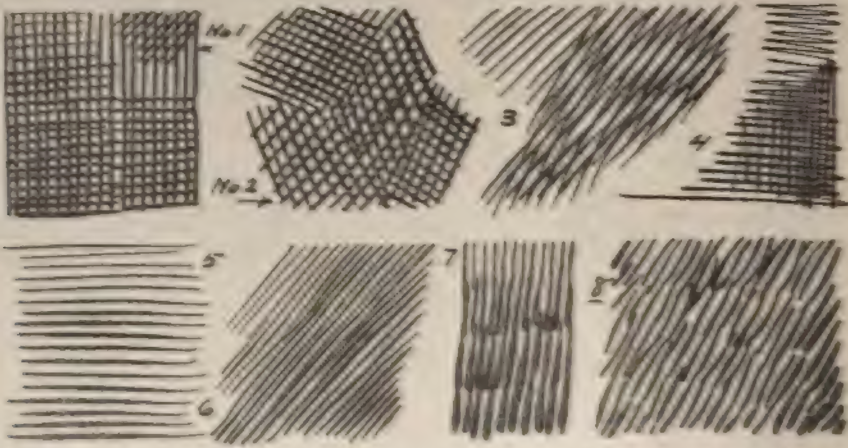
ILLUSTRATING.

Practical Advice to Beginners.

By G. H. Lockwood.

Art Instructor Acme School of Drawing.

THE author well remembers his first attempt at pen drawing and the discouraging results. Like many others, he started in without even a knowledge of the kind of materials to use, say nothing of the essential rudimentary principles of light and shade, proportion, contrast, balance, technique, etc.



In those days few there were who could teach, and many a lesson was learned by long experimentation and hard knocks. Nowadays the beginner can gain in a few days, or weeks at the most, the knowledge that cost some of us patient years of labor. It will be my purpose, from time to time, to give practical hints to those just starting in this fascinating line of study. This article will deal with just a few of the common mistakes made by the amateur pen artist.

I think the most common fault of the beginner is in making his drawings too small. He attempts to imitate the work of the printer and engraver rather than the work of the artist. I mean by this that he tries to make his drawing have the same "fine" effect as the engraved prints, not realizing that the original drawings were from four to ten times larger than the engravings from which the prints were made.

The reasons for making large drawings are many and important, and some of them are not visible on the surface. In the first place one might easily suppose that if he wished his printed drawing to

have a fine technique effect, he should have the same fine technique in the drawing. Quite the reverse of this is true. Where fine effects are desired in your print, make your drawing large and coarse so it will stand great reduction. When coarse effects are desirable in the print, for the purpose of printing easily on coarse or cheap paper, the drawing need be reduced but very litle, if any. drawing is made properly, does not change the "values" of your technique strokes; but when the lines are too fine to stand reduction, the result, in the engraving, always changes the values, either weakening your effects where the lines are etched out, leaving a broken and rough appearance; or else your print looks much darker than your drawing, caused by the lines either running togeth-

If your drawing is made large with fine lines, it will not stand much reduction. A strong, firm pen line will reduce in size in proportion to the general reduction of the drawing, but when the line is thin and weak it cannot be "thinned" or "weakened" very much in the reducing process, and so the fine lines are apt to lose out in the etching process.

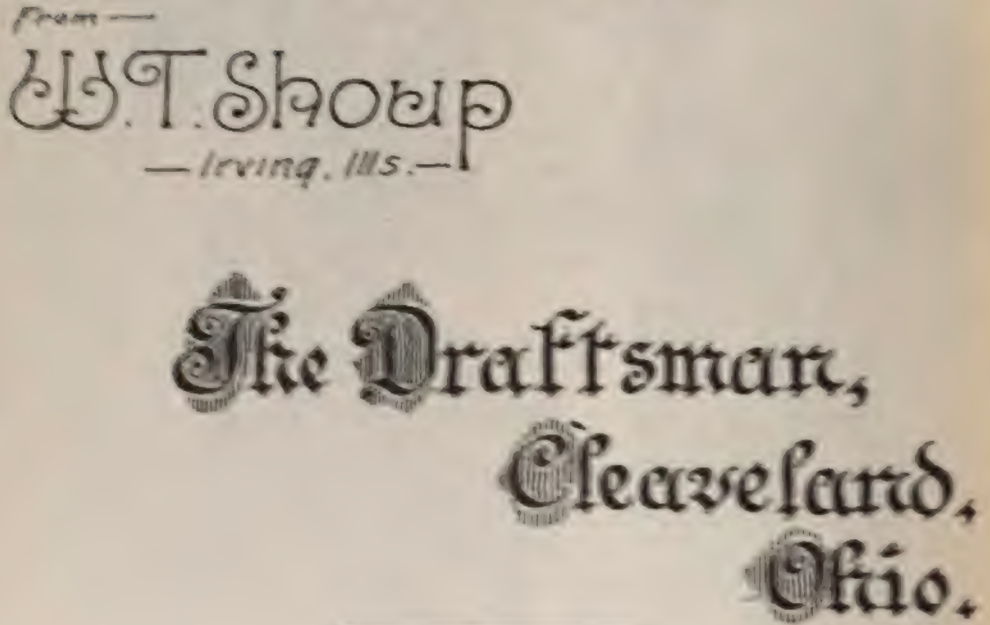
The result of reduction, when the er or else being "strengthened" in the engraving process. Either result is undesirable, and yet one or the other is practically unavoidable when the engraver has a fine line drawing for reduction. In this connection I would like to call your attention to Drawing No. 1.

This drawing was engraved "same size." Even without reduction it did not stand the process and the effect of

the print is not exactly the same as the original. The drawing is a fair piece of work but not a practical drawing. A study with the same amount of detail should be at least four times as large and the technique at least four times as strong. This would mean lines like the following.

The strokes in No. 2 were engraved same size to show you the "quality of line" you should use. The same drawing is also shown after reduction. The lesson is so plain that no more words need be said. Study these pen technique strokes and make them over and over and over.

A Fancy Addressed Envelope.



HOME STUDY.

Mechanical Designs.

CHAPTER X.

Cams.

A CAM is a piece of mechanism which transmits motion to its follower by means of its curved edge, or by means of a curved groove cut in its surface. The cam may be in the form of a plate or a cylinder. When the motion is small or intermittant, such plates are often called tappets, or wipers.

In most cases which occur in practice, the conditions to be fulfilled in designing a cam or wiper do not directly involve the velocity ratio; usually a certain series of definite positions is assigned which the follower is to assume when the driver is in a corresponding series of definite positions. In cam mechanisms, the motion of the follower is usually derived from the cam by means of a cylinder roller turning about a smaller pin as an axis, the latter being rigidly fastened to the follower. This has the advantage that nearly all the wear is concentrated on this axis, which may readily be renewed when worn out. If the pin is to be driven by the cam in one direction only, being made to return by the force of gravity or the elastic force of a spring, the cam need only have one acting edge; but if the cam is to drive the pin in both directions, it must have two acting edges, with the pin between them, so as to form a groove or a slot of uniform width equal to the diameter of the pin, with clearance just sufficient to prevent jamming or undue friction.

Illustration here shows *cam, follower, pin, rim, face, web, hub, shaft, length of hub* and other parts spoken of in the above description.

The center of the pin may be treated as practically at all times, coinciding with the center line of such a groove, which center line may be called the "pitch" of the cam.

The most convenient way usually to design a cam is to draw first its pitch line, and then to find the acting edge or edges by using a radius slightly greater than that of the pin in case the two edges are employed.

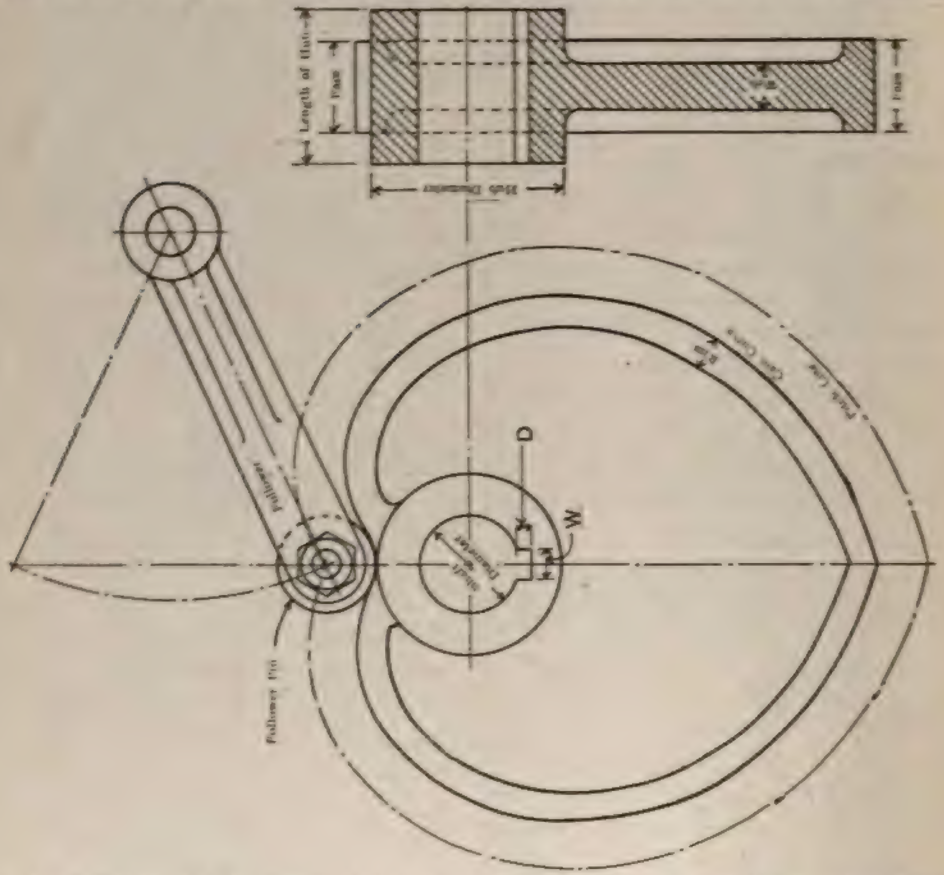
CONSTRUCTION OF A SIMPLE CAM CURVE.

In Fig. 1, let A be the center of motion of the proposed cam and BH the path of the center of the pin on the follower being on a line through A. The condition being that the point of the follower shall start from the point H, and assume in succession the positions E, D, C and B, while the cam revolves through the successive angles of 30 degrees. With center A and radius AH, describe the circle HF; produce the radius AH through the points, and draw the other

radii (produced), Ak, Al, Am and An at successive angular intervals of 30 degrees. With center A, draw circular arcs through the successive positions E, D, C, B, of the pin. Then K, I, m and n will be points of the cam curve required. The line nmlkH, called the "Pitch Line," will be the curve which will fulfill the required conditions; for, assuming the pin to be at H, and the cam to revolve in the direction of the arrow, it is evident that as the radii Ak, Al, Am and An successively come into the position AS, the points k, l, m and n of the cam curve will coincide with E, D, C, and B, respectively, thus driving the pin as required. To find the curve for a pin of sensible diameter, draw circles of the same diameter as the pin in a sufficient number of positions along the pitch line already found, and then draw the acting edge tangent to these circles.

This is a case when the path of the pin passes through the center of motion of the cam and the pitch line is drawn through the points of intersection of the successive radii and the circular arcs through the corresponding positions of the pin.

In case the motion of the follower is not required to be uniform, the distance HE, ED, DC and CB would all be unequal, but no modification of the method of construction would thereby be introduced.



In Fig. 1, the path of the follower is a straight line and the cam has uniform motion about a fixed center. But none of these conditions need to be adhered to. The path of the follower may be

any curve whatever, and it may move in this path in either direction, and with uniform or varying velocity. The cam usually revolves about a center, but its

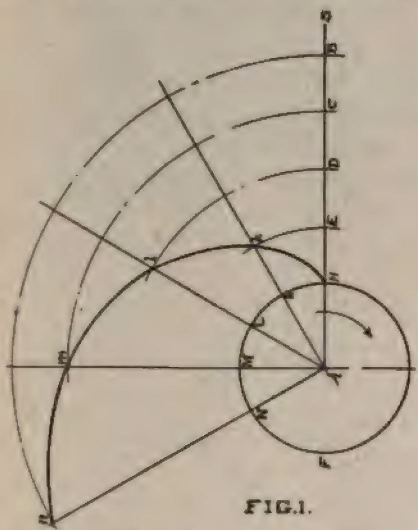


FIG.1.

velocity may be varied at pleasure. All these possible variations give rise to an endless variety of shapes for the cam curves, but the principles underlying

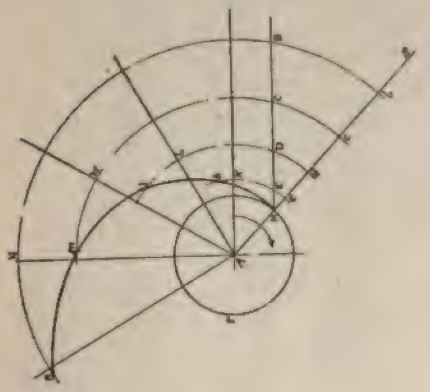


Fig. 2.

their construction are always the same.

In Fig. 2, let A be the center of motion of the proposed cam and BH the path of the center of the pin on the follower, the condition being that the center of the pin shall start from the point H and assume in succession the positions E, D, C and B, while the cam revolves through 45 degrees and three angles of 30 degrees each. With center A and radius AH, describe the circle H F.; produce the radius AH to S and draw the other radii (produced), AK, AL, AM and AN at successive angular intervals of 30 degrees. With center A, draw circular arcs through the successive positions E, D, C, B, of the pin and on these arcs lay off the distances Kk=Ee, Ll=Dd, Mm=Cc, and Nn=Bb. Then k, l,

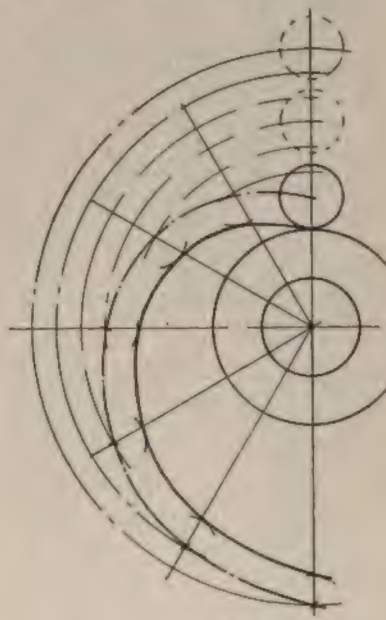
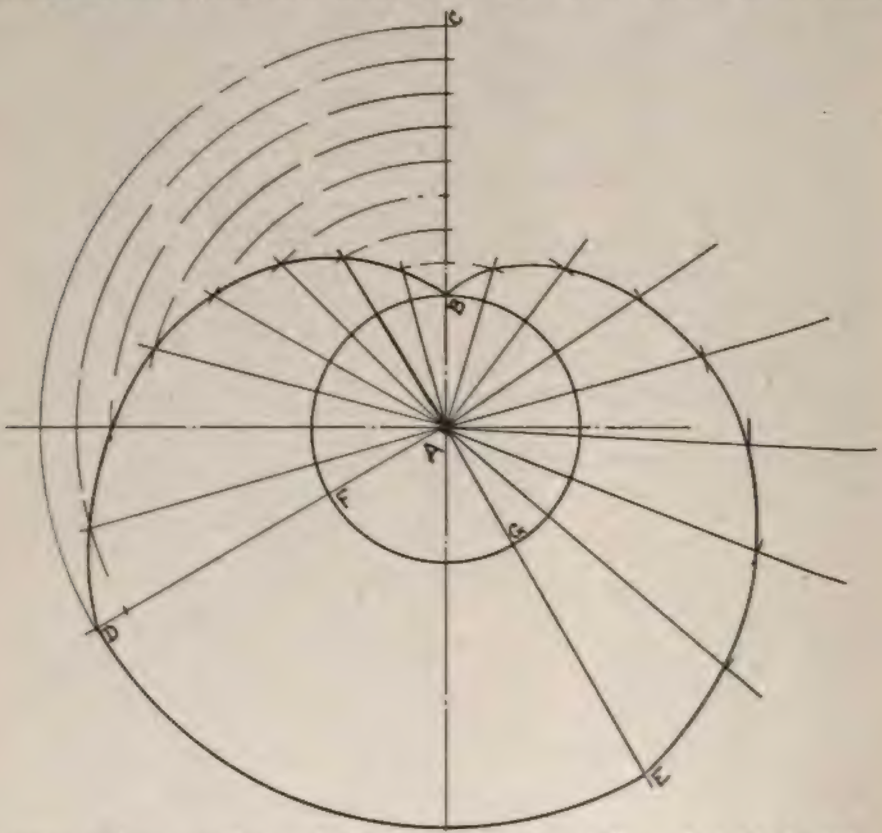


FIG.3.

m and n will be points of the cam curve required. The curve nmlkH, drawn through these points will be the curve which will fulfill the required conditions; for, assuming the pin to be at H, and the cam to revolve in the direction of the arrow, it is evident that as the radii AK, AL, AM and AN successively come into the position AS, the points k, l, m and n of the cam curve will coincide with E, D, C and B, respectively, thus driving the pin as required. To find the curve for a pin of sensible diameter, we proceed as stated in Fig. 1, drawing cir-

cles of the same diameter as the pin in a sufficient number of positions along the pitch line already found and then drawing the acting edge tangent to these circles.

When the path of the pin passes through the center of motion of the cam, the distance Ee, Dd, etc. all reduce to zero; and the pitch line is drawn through the points of intersection of the successive radii and the circular arcs through the corresponding positions of the pin as in Fig. 1.



As the angle BHS increases, the action between the edge of the cam becomes more oblique, thus increasing the friction; and it is hence advisable to make that angle as small as possible; in other words, the path of the pin should point as near as possible to the center of the motion of the cam.

"Sensible diameter" means that the follower pin is of something more than a mere point and Fig. 3 shows the cam curve found by drawing arcs from points in the "pitch line," and illustrates what would be the result of following Prob. 3.

PROBLEMS.

I. Draw a cam curve to move the follower ½", ¼", 1", ¾" and ½" in five successive movements of the cam of 30 degrees each, then drops the follower to the hub, where it rests for the remainder of the revolution. Let AH be 1".

II. Draw a cam curve to operate a follower whose path is ½" off the center of the cam.

The follower moves ¼" in the first 30 degrees, ½" the next 22½ degrees, ⅝" for 22½ degrees, then ¾" in 30 degrees and drops back to the hub. Hub 2" in diameter.

III. Draw a cam curve to move a follower, having a pin 1" in diameter.

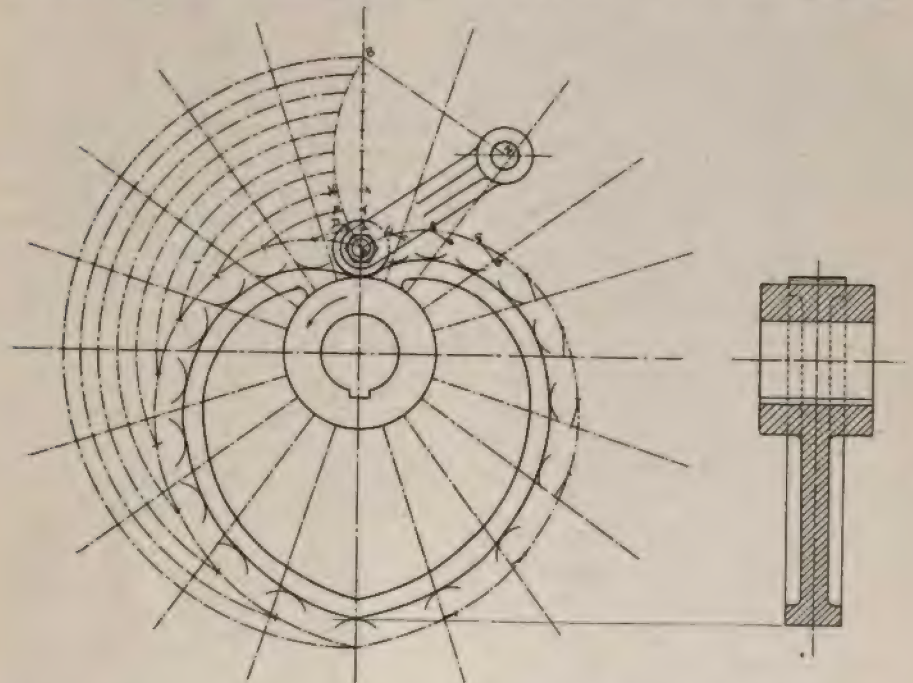
through three points ¾" apart, vertically in ½ of a revolution, then drop it to the hub. Hub to be 3" in diameter, shaft 1½". (For a student in drawing, these three problems can be laid out nicely on a sheet which has a space of 13"x17" inside the border lines.)

(Locate Fig. 1 4¼" from top and left border and Fig. 2 on center line of Fig. 1 and 4¼" from right border line of sheet. Center of Fig. 3 to be 4½" from bottom border and central of sheet.)

In Figs. 1 and 2, the direction of rotation of the cam must be reversed in order to bring the pin down again to H, unless it be allowed to drop off at n and slide along on the circle HF, until it arrives at H. But a slow return may be accomplished by simply adding to the curve of the cam, in which case the latter may revolve continually in the same direction. The motion of the pin in one direction may be entirely different from that in the other direction, and the pin may be given an interval of rest at any elevation by making the corresponding part of the cam curve an arc of a circle.

In Fig. 4, let A be the center of motion of the cam, and let the vertical line BC be the path of the follower. The cam is to revolve uniformly and lift the follower 2" in 1-3 of a revolution, then let it rest for ¼ of a revolution, then return it slowly to the starting point.

Draw the same number of equidistant radii in the 1-3 of a revolution, as the path is divided, and draw circular arcs through the various positions of the follower, finding the points as before.



The interval of rest is indicated by the circular arc from D to E which is for ¼ of a revolution. The cam now allows the pin to recede, so draw in the same number of equidistant radii in the remaining portion of the revolution as in the first 1-3 and find the points in the curve in the reverse manner as in Fig. 1.

The curve is now ready to move the pin in the same way as it did in the previous revolution and will continue to do

it as long as the cam revolves.

Fig. 4 only shows the pitch line of the cam.

Fig. 5. Let the path of the pin be the curved line AB and let the pin move up and down uniformly, while the cam revolves in the direction of the arrow through one revolution. The equidistant radii being drawn so as to give the same number as in the path. Draw circular arcs through the points of the path, and the pitch curve is found just as in Fig. 2, by making Cc=Dd, Ee=Ff, Gg=Hh, etc.

Then draw arcs from the respective positions of the pin and trace in the "acting edge" of the cam.

Prob. 4. Fig. 4. Let AB=1". Bc=2". Arc B F is 1-3 of a revolution. FG = 1/4 of a revolution and GB the remainder.

Prob. 5. Fig. 5. Draw a cam to operate a follower pin which moves in a circular path, total rise 5" in half revolution of the cam. Follower pin 1½" diameter. AZ to be 6". Shaft 1½" diameter. Hub 3" diameter and 2½" long. Web ¾" thick. Face 1½" wide. Rim ½" thick.

(Draw a horizontal line in the center of the sheet for a center line of Figs. 4 and 5 and lay out Fig. 4 4½" from left border line. Locate center of Fig 5 5½" from the right border line and draw it half size, that is, make all parts one-half as large as these dimensions would call for and put on the actual figures.)

Angles.

Working to an angle is a very perplexing thing unless one has a Drafting Machine or a protractor.

With the tee-square always loose, it may be slipped around so that with the triangle against it, we can draw a series of lines parallel to some other line. The same may be said of the triangle against the other as shown in Fig. 1.

Letting D represent the 45° triangle and C the 30-60°, a line perpendicular to D may be drawn as shown in dotted and

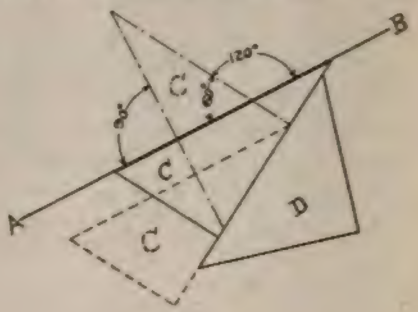


Fig. 1.

at the same time a line perpendicular to AB, the original line.

Always lay the long edge along AB if you wish a line perpendicular to it when the triangle is turned as shown dotted.

When turned as shown, the back of C will make angles of 120° and 60° with AB.

Fig. 2 will illustrate some angles obtained by placing the two triangles on each other as shown. Angles of 15°, 30°, 45°, 60°, 75°, 90°, 105° and 120° are possible with these triangles.

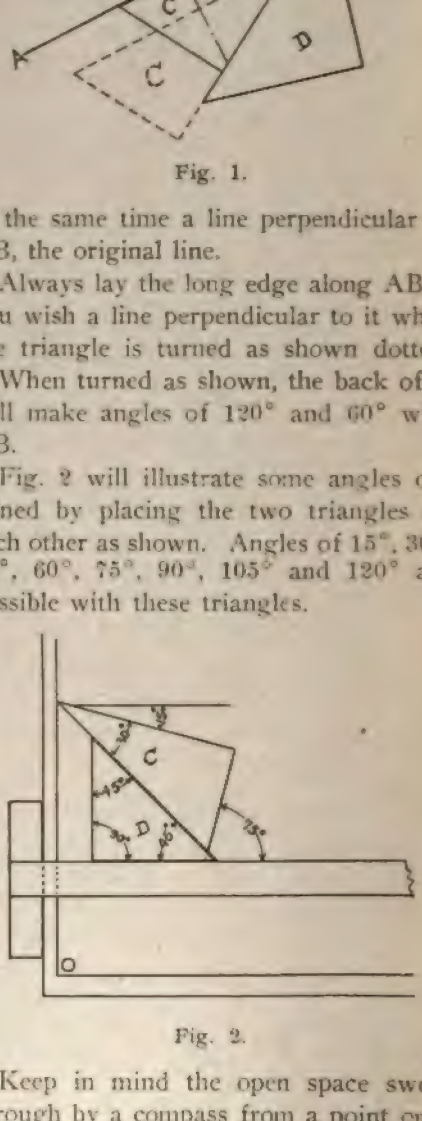


Fig. 2.

Keep in mind the open space swept through by a compass from a point on a line is 180° when the pivot point is on the line too.

Of the 30°, 45°, 60° and 90°, no one angle is the more common unless we

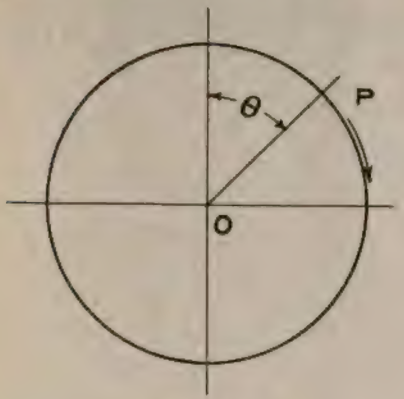


Fig. 3.

would say the 90°, yet few things, especially in building construction, remain perpendicular.

If an object rotates about a point, it may be said to pass over or through an angle of so many degrees, but there are no right or left-hand angles.

Angles are often denoted by a Greek letter as in Fig. 3, and if the angle was 30° we would say, angle *theta* is 30°.

An angle and its *complement* is equal to 90°.

An angle and its *supplement* is equal to 180°.

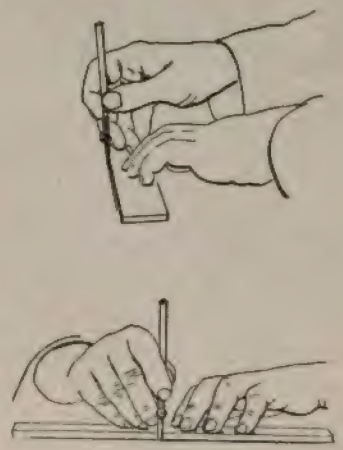
Holding the Ruling Pen.

To the beginner, the proper position of the ruling pen will be more or less strained if held as illustrated, the tendency being to lay it over some to the right if we draw from left to right.

Many draftsmen have this habit, too, and it may not be considered very bad after all, yet the best results come from a vertical position.

One thing to be remembered is to keep the pen at right angles to the paper as in the upper part of the illustration. Do not let the point reach out or in from the straight edge.

If out or in, there will be a ragged line and if by the latter position the ink is



liable to run under the straight edge and make a blur.

The illustration is taken from "Lettering" and Lininеer Drawing, by Mr. Fish.

Mercury boils at 662° F. and freezes at 71.8° F. below zero.

Instead of writing "revolutions per minute" in full, we may write R. P. M., which will be clear enough.

It has been said that formulas will express more on a square inch of paper than words on a whole sheet. It must be borne in mind that each letter and figure in the formula must be clearly described.

How large a circular piece in diameter should be to be milled down square, multiply the side of the square by 1.414 and the product is the diameter to turn the piece of work.

One of the common errors in reading a drawing is to mistake a dotted line for a full one. Dotted lines are drawn to represent three things; first, a part that is below the surface; second, a piece that is to be taken off; third, the different position of a moving piece.

CURRENT TOPICS.

Some men learn by doing, some by being done and some never learn at all.

Did you get your present for the names of students or others interested in drafting? Send in a few names and get one.

No doubt the draftsmen are looking forward to vacation time; perhaps some have already taken theirs and are back at work again.

We desire to obtain for our supplements as much original matter as possible, that matter not shown in hand-books is much more desirable.

Perhaps there are some young men in the shop who would like to see a copy of *The Draftsman*. Let them read the advertising pages for premiums.

Did you ever use a fountain ruling pen? No doubt they would be a fine thing. Think of the time saved. Mr. Louis Winter, of Reading, Pa., is advertising some of them in this issue.

The Browning Engineering Co., of this city, has set aside the first week of July in which everyone will take his or her vacation, the shop closing down for the week. In this way the matter of vacation will be settled for the year and not be spread over several months.

We beg to announce a second edition of our book, giving Dimensions of Pipe, Fittings and Valves.

No doubt our customers felt that we were running a "get-rich-quick" joint, for we had many orders before it was completed. We now have a big supply, carefully printed, with only a small amount of new matter added. Price in cloth, 50c. What new matter is shown will be given in supplements so everyone will have it.

We feel it is the cheapest book on the market for the material it contains, but the price will not be raised.

Our much-called-for booklet, entitled, "A Chapter on Lettering," is also finished. It contains a lot of neat alphabets, titles, initial letters, monograms, fancy card and borders. Price 25c.

It is said that The ——— Co. will "stand for more" in their drafting rooms than most any employer of draftsmen in the country. Why should they? Do they need the men or have they foremen that put up with more?

Perhaps the latter, for they recently let fifty men go, but yet they were ones that weren't altogether efficient. There is no doubt but that draftsmen are like those of other professions and trades, the less efficient are laid off.

One concern in this city have their draftsmen keep their feet out of the windows to save room, as they are so badly crowded.

This concern treat their men well but generally when work is slack the worst ones get the notice to move, thus giving the impression that draftsmen are not stayers.

To Readers of The Draftsman.

I am a reader of THE DRAFTSMAN, as well as a great many other trade journals, and in comparing THE DRAFTSMAN with some other up-to-date papers, I saw fit to criticise its editor and I am glad I did, for his reply shows me that he deserves much credit for giving the draftsman as good a paper as this is. He tells me that he has been working for several years, almost single-handed, to give his readers a good paper. If the paper is not as good as it ought to be I rather blame its readers.

You who read this think of some contribution you could write that would be of interest to others. *The Draftsman* bids fair to be a great help to its subscribers, but a paper of this kind must have a lift from the tradesmen. I heartily agree with J. S. Myers. "Come on, now, and give it a lift."

305 Franklin St. E. A. CLARK,
Waukegan, Ill.

Why Not Organize?

It is with much interest that I write concerning your very interesting journal and the instructions contained therein, which you strive to inculcate in the minds of those who read it. With its power of thought, it could be still more influential by becoming the medium through which draftsmen of all lines can become more familiar and in touch with one another. With this in mind, it is my purpose to make mention of a plan which I have thought of "and no doubt many others" have many times. It is to form an association of operative draftsmen, the objects of which may be fraternal in a degree, but in the main would be for the purpose of advancing the art in its various branches, as well as its members to a higher standard of achievement. In the solicitation of its members it is of the most importance to have all who believe themselves not too wise to learn and after learning help his brother "pencil pushers" push on to success; for it is not all by our own efforts that we become successful, but by the little helps of others. An organization of draftsmen should have a standard in the selection of its members, i. e., an examination that would not be too exacting or too lenient in determining the quality of the applicant and being broad enough in its requirements to select only those who will help maintain its objects. A few objects to be considered and which should be enacted in such an organization would be an information department, it being the source through which the members could keep posted regarding positions of better value. I do not wish to convey to the reader that this department should be the means of obtaining "snap jobs," for that is just the reason why there should be an examination to membership, it being so constructed as to eliminate those who are looking after snaps and have no other motive for joining than self.

Now a word as to the fraternal feature in such an organization. This can be eliminated to a few essential parts, such as a recognition hand shake, sign and an emblem of some design worn in the lapel of the coat. There could be a benevolent department to aid the sick and disabled, such fund being set aside from the regular dues of the members.

The proceedings of all meetings could appear in the columns of *The Draftsman*, thus making it an additional value to its readers and the organization.

I would be pleased to see the expression of others on the subject and see if such a project cannot be pressed to a definite issue.

A PENCIL PUSHER.

Horse Power of a Wind-Mill.

To calculate the horse-power of a windmill approximately, multiply the area of the slats in the plane of revolution by the cube of the velocity of the wind in feet per second and divide the product by 4,000,000. (This does not apply to all persons, however.)

NEW INVENTIONS.

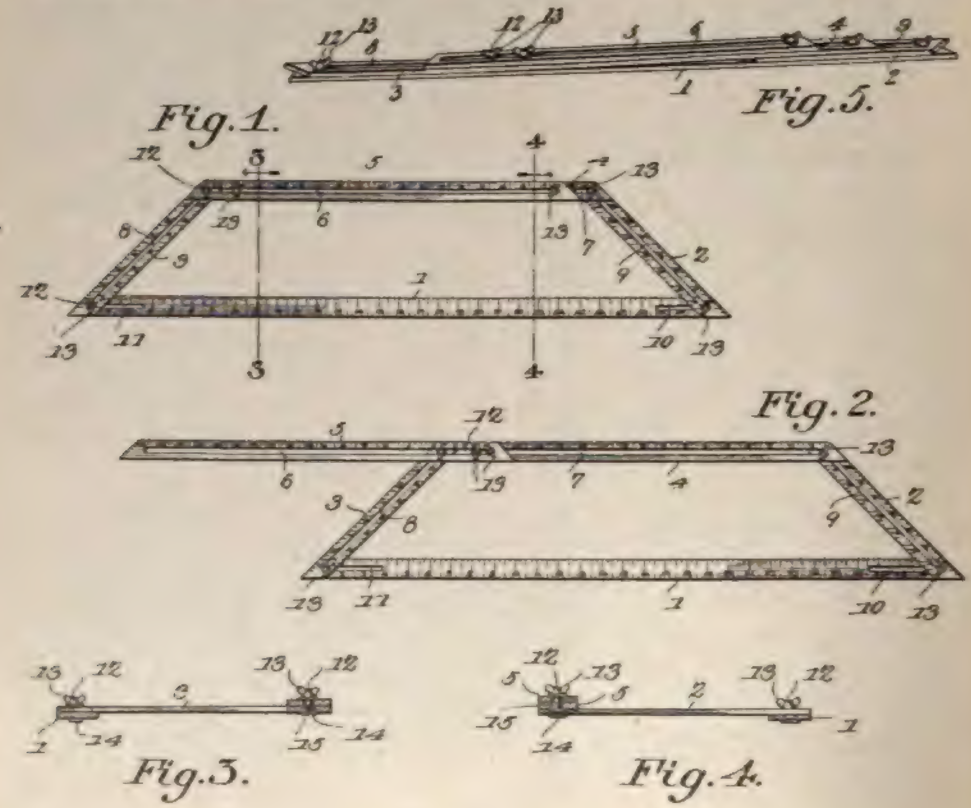
The following inventions have been specially reported for THE DRAFTSMAN by C. Leroy Parker, solicitor of patents, 707 G street, Washington, D. C.:

MEASURE.

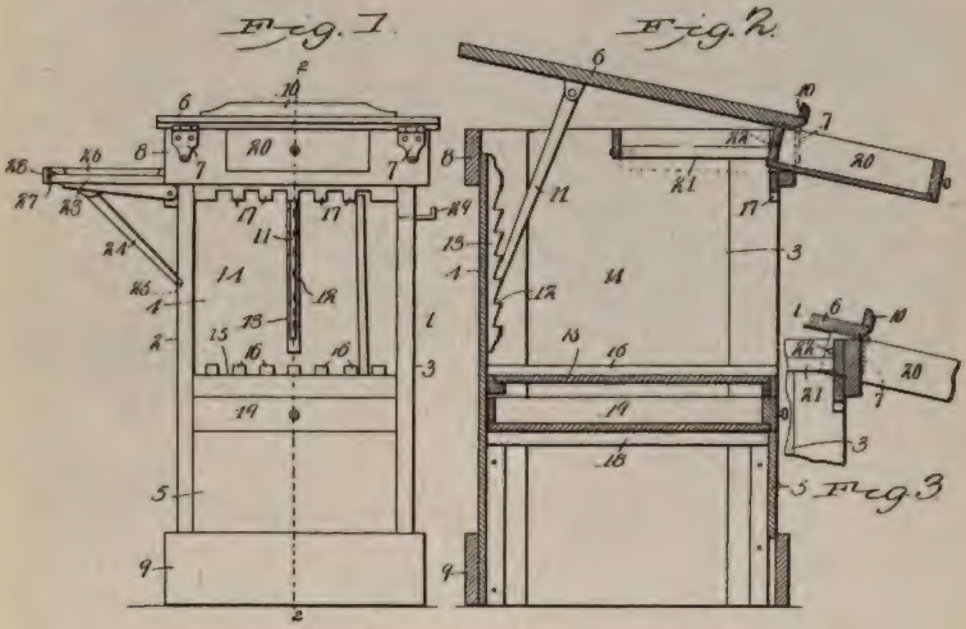
No. 783,863—A. L. Hapgood, Fed. 28, 1905. A measure comprising a graduated length-scale member having slotted terminals, graduated width-scale members having longitudinal slots, longitudinally-slotted extension members and means for adjustably connecting all of the members, the terminals of all the members being disposed at an angle of forty-five degrees to their length.

DRAWING BOARD.

No. 783,973—E. E. McAnelly, February 28, 1905. This invention relates to a drawing desk or stand, and has for its objects to produce a simple, inexpensive device of this character which will be strong and durable and one which in practice will meet all the contingencies attendant upon storing the paper, instruments, boards, etc., or arranging the same for use and for maintaining the work at the proper inclination while being executed.



To these ends the invention comprises a desk, a pivoted cover therefor adapted to be adjusted at an inclination, guide-rails carried by the desk, a drawer supported by the rails and adapted for outward movement, and stop members carried by the drawer adjacent to its rear end and adapted for engagement with the front wall of the desk to limit the outward movement of the drawer, the rear portion of the drawer when drawn outward being designed to bear against the front portion of the cover to impart to the drawer a downward inclination coincident with that of the cover when adjusted.



MACHINE FOR CUTTING ELLIPSES, OVALS, OR CIRCLES.

No. 785,087—Robert Carlton, March 21, 1905. This invention relates to a novel drawing or cutting machine, the primary object being to provide in a machine of this character means whereby the connections between the cutter and the operating handle may be set with convenience and precision for the drawing or cutting of circles, ellipses and ovals of various sizes.

In the operation of the machine, if it is desired to inscribe or cut an ellipse, the cutter or pencil holder 26 is adjusted along the cutter-bar until the distance from the cutter to center of the ellipse, found by means of the centering-pin 25, is one-half of the minor axis of the desired figure. The difference between the minor and major axis being known, the slide 12 is now moved back to the right sufficiently to separate the axis of the two shafts 14 and 21 by an interval equal to one-half of the difference between the major and minor axes, this adjustment being facilitated by the graduations on the scale. If now the handle-shaft 14 is rotated, corresponding rotary movement of the cutter-bar shaft will be effected, and the cutter-bar will likewise swing to describe a curve, of which the center of the cutter-bar shaft will constitute the axis. This curve, however, will not be in the form of a segment, because the accentric relation of the two shafts 14 and

21 and the limitation on the movement of the shaft 21 by the shifter and the arms 34 and 35 will compel the simultaneous lateral movement of the shaft 21 in a direction substantially transverse to the arm 6 and of the shaft 14 in the direction of the arm. It follows, therefore, that since the cutter or pencil swings from the cutter-bar shaft as an axis and since said axis shifts in a direction transverse to the supporting-arm during the movement of the cutter the latter will necessarily describe an ellipse.

No. 785,087. PATENTED MAR. 21, 1905.

R. CARLTON.

MACHINE FOR CUTTING ELLIPSES, OVALS, OR CIRCLES

APPLICATION FILED OCT. 20, 1903.

2 SHEETS—SHEET 1.

Fig. 1.

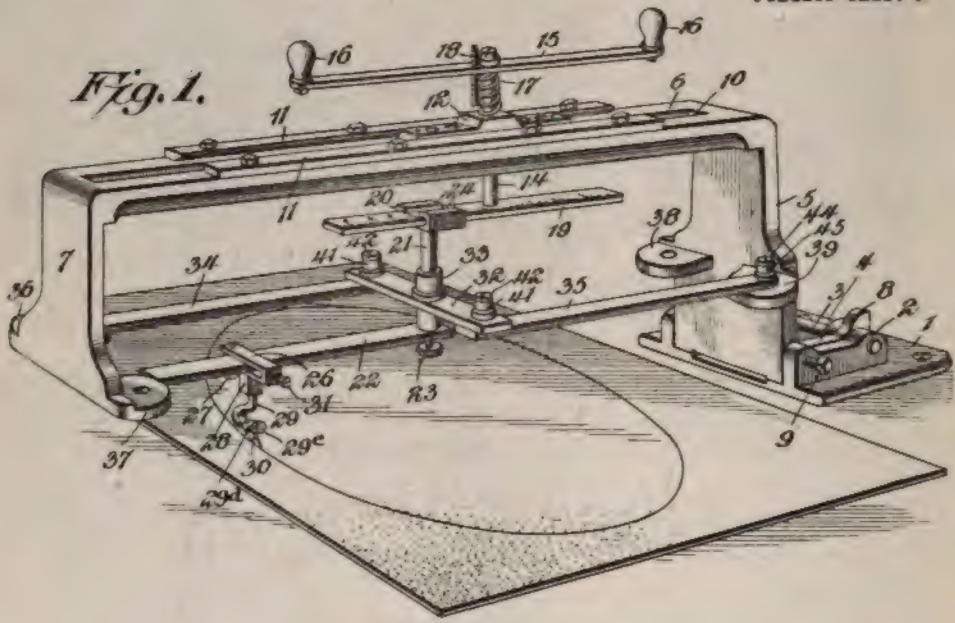
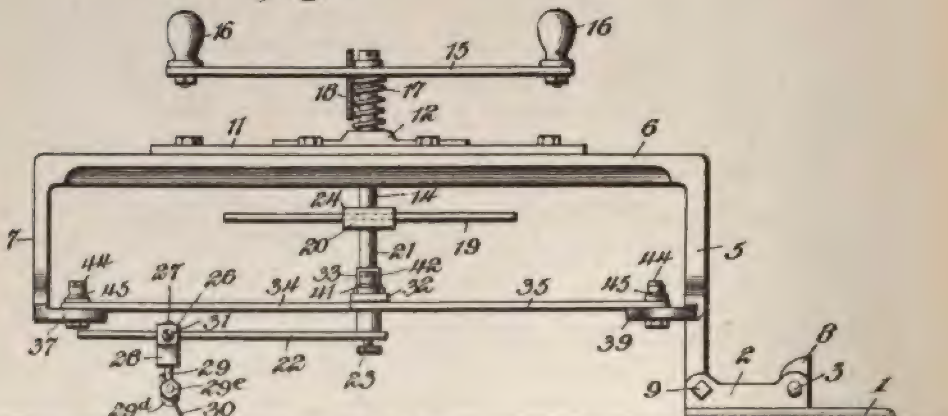


Fig. 2.

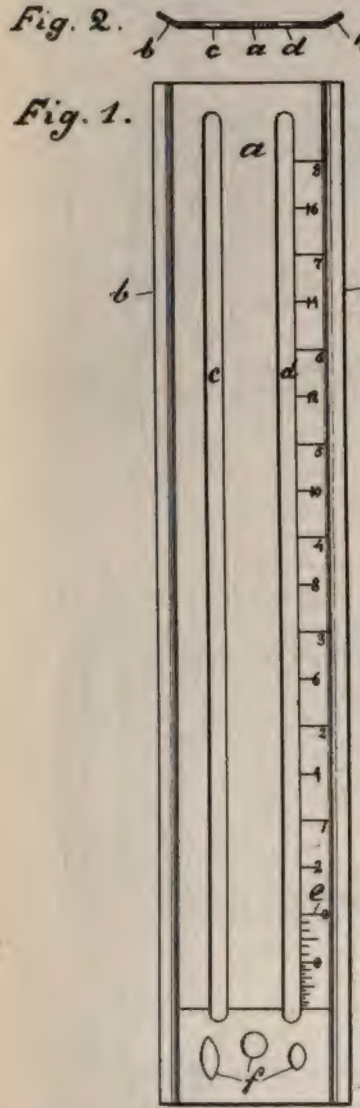


MULTIPLE SCALE RULER.

No. 784,274—Knut M. Pauli, March 7, 1905. The object of this invention is to save time in making mechanical drawings and constructions and for this pur-

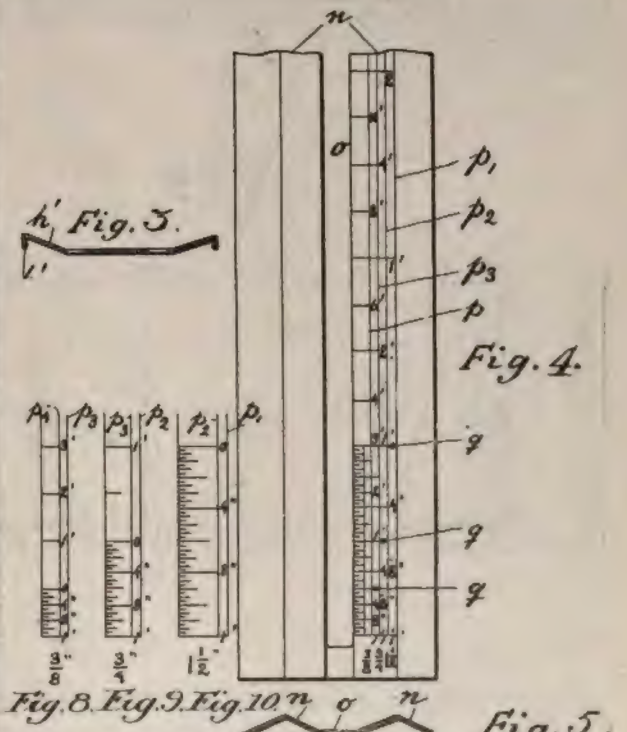
pose to use rulers, triangles and squares, graduated in different divisions or scales, whereby the draftsman is able to set off or measure a certain line on the drawing quickly.

The parallel multiple-scale ruler shown in the illustration is stamped out of a sheet of suitable material a, the edges b being turned up a little to be used with ink. Two long slots, c and d, with parallel edges are formed and the four latter provided with graduations e. The bending of the outer edges of the ruler makes the instrument strong, and it is hence possible to use a thin sheet of metal or other material in the manufacture of the instrument.



ROLLER PRINTING FRAME.

No. 785,566—Gustave C. Olsen, March 21, 1905. This invention relates to blue-printing frames; and it has for its object to provide a printing frame wherein the paper to be printed will be in the form of a roll which will be unwound and passed beneath the negative into position for printing and after being printed will be wound upon a roller sufficiently far to shift the printed part of the paper from beneath the negative and bring a fresh or unprinted part of the paper into position for printing.



The construction is obvious from the accompanying illustration.

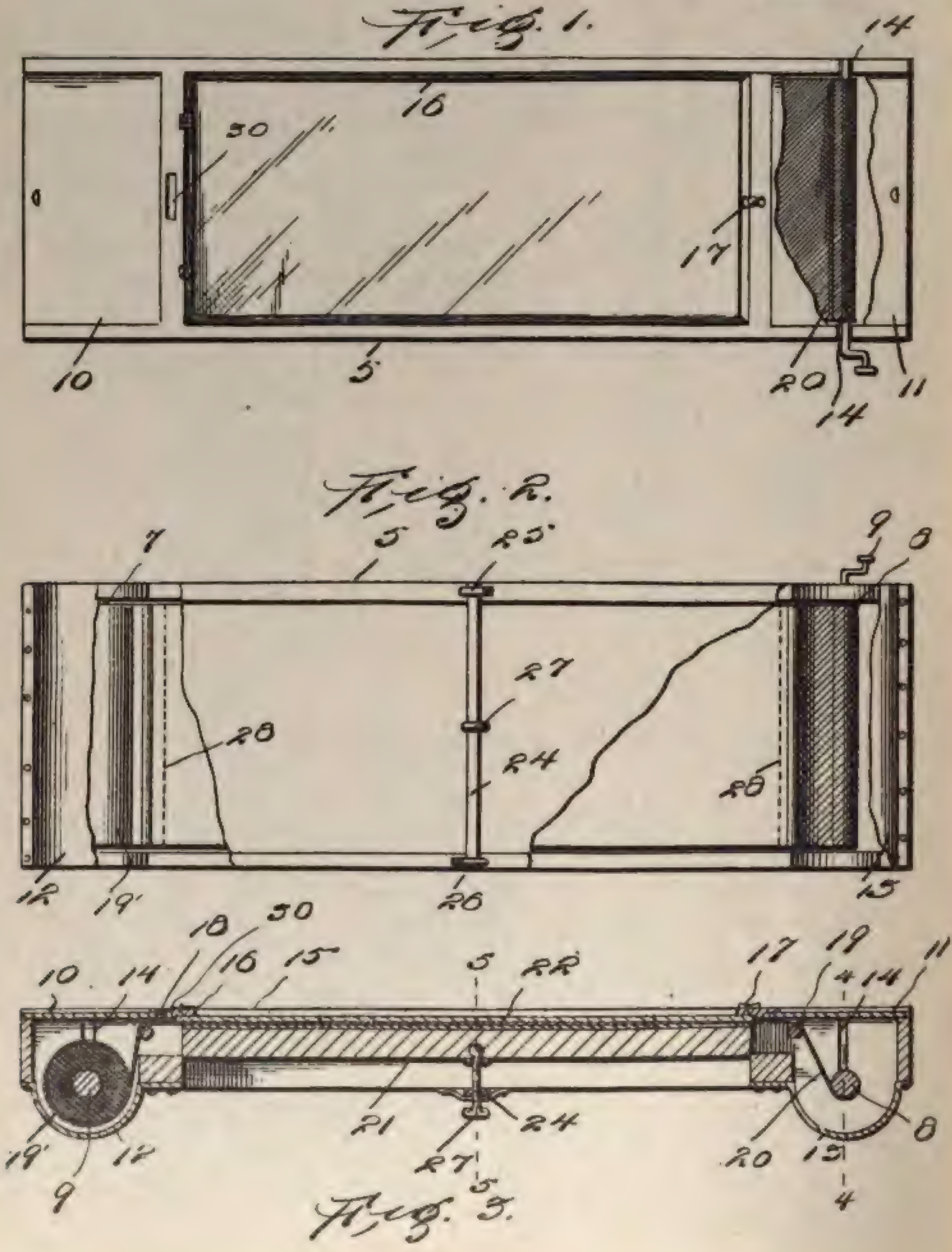
No. 785,566. PATENTED MAR. 21, 1905.

G. C. OLSEN.

ROLLER PRINTING FRAME.

APPLICATION FILED MAY 17, 1904.

3 SHEETS—SHEET 1.



Blue Prints in a Hurry.

Being a draftsman for a firm whose business it is to build special machinery, I have many times had to "dig" to get out some small drawing in a hurry. We have found that to send a pencil drawing to the shops is very unsatisfactory, even where the job is small and the time consumed in making the tracing and the blue print causes delay of considerable account. To overcome the matter of making the tracing I am now employing a method which is not original, however, that proves a great saving of time. I make my drawing on a tracing paper, which I procured from Eugene Dietzgren & Co., which he catalogues as 178 "Natural," and I find this paper , using a 2 H pencil, will make a very satisfactory blue print, thus eliminating the extra time of any tracing. I recommend this not only for hurry jobs but I am using it for a great deal of my detail work.

E. A. C.

New Tortosa Observatory.

The new observatory of physical astronomy at Tortosa; in Catalonia, is one of the finest of the kind. One of the chief objects of the authorities of the new institution is to discover the relations which may exist between magnetic, electric and solar disturbances. These phenomena are to be registered at once and regularly so they may be studied seriously. Of the seven buildings in the establishment two are devoted to magnetism, one of which is reserved for instruments of variation and the other is used for absolute determinations. Another of the buildings is devoted to meteorology and electricity, another to seismology, and one pavilion is entirely given over to physical astronomy. All these various departments are well supplied with the most modern apparatus and inventions for the study of the various subjects, and all that is now desired is a monthly record of the work of this observatory for the benefit of the world at large.

Leather Railroad Sleepers.

The authorities of the Russian railways are considering an odd proposal to replace the wooden sleepers under the rails with sleepers made of leather, and have decided to carry out experiments on the state railways. It is claimed for the curious project that neither air nor weather has special influence on leather sleepers, that they do not crack when nails are driven through them, and that they are less costly than wood as they remain longer in use.

Ocean Map Almost Completed.

The famous ocean map planned at the international congress in Berlin in 1899 is almost ready for publication in the form of an album of twenty-four pages. This great work was undertaken because of the impossibility of any one nation arriving at an exact knowledge of oceanography. While great strides were made during the latter half of the last century for submarine telegraphy and for fisheries a more exact knowledge was absolutely necessary. With the only two general bathymetrical maps hitherto in use—that executed from the reports of the Challenger expedition and that of the German navy—both are carried out on so small a scale there is not room enough for details. In 1899 it was decided to construct a map of the oceans, and an equivalence of terminology in the various countries was adopted to avoid confusion. The commission decided in 1903 how the work of the new ocean map should be carried on, and six chartographers at once set to work. The first installment was shown at the international congress

of geography, held in Washington last September, when the body congratulated the Prince of Monaco, as president of the commission, on the work done. The map has been continued at Monaco, under the supervision of Charles Sauerwein, a midshipman, and Prof. Thoulet, to whom the calculations are due, and is to be published in May.

BOOK REVIEWS.

THE AUTOMOBILE HAND BOOK. By L. Elliott Brooks. Pocket size, 4x6½. Over 200 pages and 100 illustrations. Limp leather, price $1.50. Frederick J. Drake & Co., publishers, 211-213 E. Madison street, Chicago, Ill.

This work has been written for the practical information of owners, operators and automobile mechanics, giving full and concise information on all questions relating to the construction, care and operation of gasoline and electric automobiles, including road, motor, carbureter, ignition battery, clutch and starting troubles.

It is the intention of the author to produce a book whereby the perusal of it for a few minutes when troubles occur, would save much time and money.

It is a companion book, to be carried at all times, in fact, could be kept in the tool box. The matter is arranged alphabetically, there being no index or contents, and the book is used like a dictionary.

WORK SHOP COMPANION. Size 5x7, 160 pages, stiff cloth binding; price 50c The Industrial Publication Co., 16 Thomas street, New York, publishers.

We believe this is a revised edition of the work, containing a big collection of useful and reliable receipts, rules, processes, methods, wrinkles and practical hints for the household and the shop.

The work is arranged alphabetically that the seeker of information may easily find the matter desired. There is also an index which will enable one to scan the contents and readily become acquainted with the many subjects treated. Over 600 are listed, which makes the work an exceedingly useful one.

Good Reading.

After sorting out the back copies of THE DRAFTSMAN for bound volumes there remain a few odd numbers, about an equal quantity of the following issues The more important articles are here given and there are many illustrations to each one.

January, 1902—

Engine Proportions.

Boiler Notes. Dimensions of Keys. Notes on Cranes.

Design of Scissor Trusses. Gas Pipe for Building.

Concerning Beams, I. Standard Connections. Angles. Lettering.

February, 1902—

Engine Governors. Cost of Horsepower. Boiler Bracing.

Concerning Beams II. Numbering Drawings. Drawing Boards. Rivet Heads.

March, 1902—

Arms of the Pulley. Transmission of Power by Ropes.

Rules for making Shop Drawings.

Gauge of Track on Curves.

Indexing Periodicals, etc.

Blue Printing by Electric Light.

While there are a set of three in stock they will be sent, postpaid, for 10 cents.

This is fine material for your note book. Order at once. Address,

THE DRAFTSMAN,
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Don't accept notes for happiness. You'll find that when they're due they're never paid, but just renewed for another thirty days.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Drafting Room Practice.

By E. J. LEES.

THERE are times in the drafting room when changes and improvements necessitate quite a little erasing on tracing cloth and the draftsman to whose lot this job falls will no doubt remember what a finger-cramping experience it is.

ERASING SHIELDS.

For this reason the writer has made a special erasing shield for use on tracings, which reduces the labor considerably.

A piece of spring steel saw blade was secured and outlined as per Fig. 1, the metal being about 1-32" thick. To cut out the slots and not distort the plate an emery wheel was used, as per Fig. 2; this gave a very good slot and thinned down the metal at the edge, so no other thinning was necessary, except slot "a," which is so small that it was necessary to thin the surrounding plate for about an inch or so in diameter.

So far the shield doesn't differ from the ordinary one, except in stiffness, and this is what was wanted, as in each corner small needle points are inserted, about the same size as are used on a small pair of compasses.

The method of securing these needle points in the plate is shown by an exaggerated section. In order to keep the plate true and not have to draw the temper, the holes were punched in place of drilling, they were then reamed taper from both sides. The needle points are made from rather heavy sewing needles, temper drawn enough to file, and beveled to suit plate and then riveted in, cut off about 1-16" and then filed down to correct size on the under side.

This shield will hold a tracing down when not fastened on the board, or if fastened will hold the portion being erased separate from the rest, that is, the pull comes in the area of the shield and not all over the tracing, and the shield will remain in position with the slightest pressure of the hand while erasing.

AUTOMATIC INK SHADING PENS.

The writer has found the above pen very handy in the drafting room. For

large, rapid lettering on covers of drawings, lists, etc., it works very well.

Sometimes quite an area is required blocked in with india ink. This pen can be used to draw in the border of the space and then fill in with a camel's hair brush. A straight edge can be used with the pen, provided one keeps it far enough away

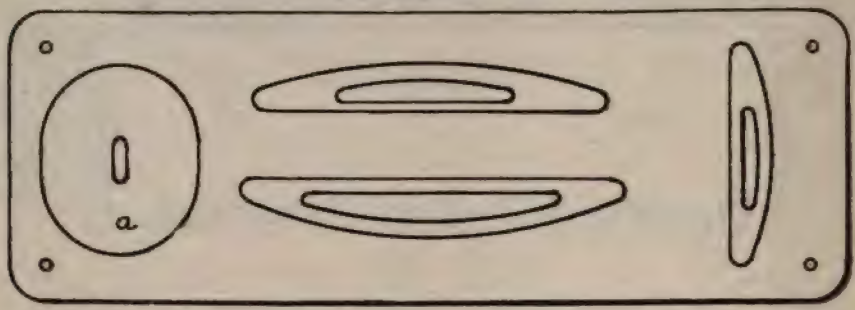


Fig 1

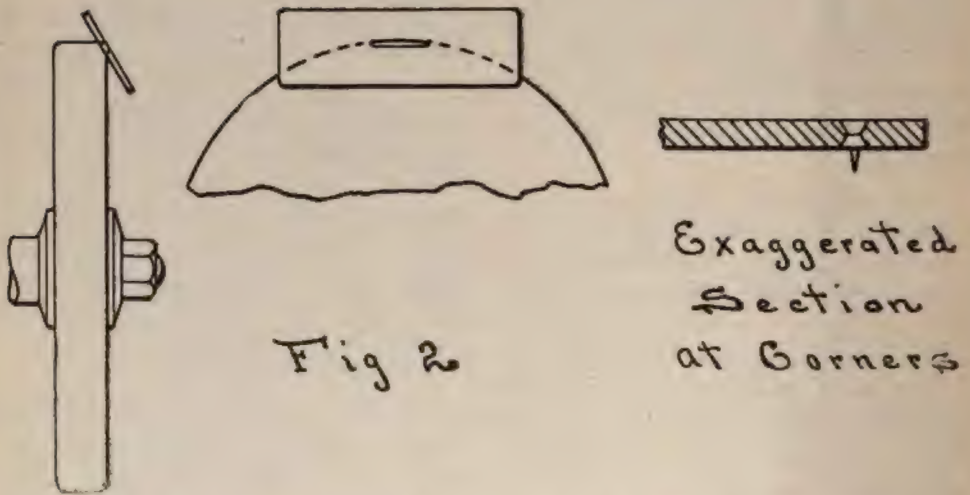


Fig 2

from the drawing so the ink does not flow down and make a blot.

One of the short cuts that can be made when a correction or addition is desired on a blue-print, is to mark the print with India ink, as wanted, then take the pen with soda water in it and mark over the lettering. This makes a neat rectangular white space with the figures or lettering inside. Two widths of pens ought to cover most of the work done in the general run of drafting rooms.

SECTION LINING, DITTO MARKS.

In one of the mechanical papers not long ago a writer made the statement that mechanical draftsmen carried the practice of section lining too far and compared our work with that of architectural work, saying what a tedious operation if all the shingles, etc., were drawn out.

At first thought it may look as though we went to unnecessary pains to section a whole view, but when you look into the

matter further one finds that if changes are made or the view is a little complicated, that the complete sectioning will oftentimes make it so clear that it is worth the trouble and may be the means of saving hundreds of dollars' worth of work from being spoiled. This is along the same line as using ditto marks, which at times are very misleading. Suppose a table of dimensions is made, parts of machines and several dimensions are the same in vertical columns, the temptation, of course, is to ditto mark down these columns. Well, after the table is all completed someone wants it to send to a printing office to be set up for catalogue and says, "Won't you insert between two sizes of machines another set of dimensions of a prospective machine?" You do so, and do not notice the ditto marks, and your new dimensions are now ditto marked all below and, of course, all wrong.

This is only one illustration but goes to show one cannot be too careful in the drafting room, and what to a great many seems to be red tape and unnecessary labor, is, after all, the correct way to do the work.

Practical Letters.

THE DRAFTSMAN, Cleveland, O.

Gentlemen:—The writer desires to thank you for sample number of paper just to hand. In looking over this May issue, especially the article on "Pulleys and Fly Wheels," the following occurs to me:

The proportion commonly given for arm at rim in the plane of the wheel, "two-thirds of the arm at center" is undoubtedly theoretically correct, assuming the arm to be in the condition of a beam, fixed at one end and loaded at the other.

On a series of pulleys, however, of varying diameters, it does not satisfy the eye as well as a standard taper, owing to the variations which arise if "2-3 h." is used, and the unpleasant contrast this makes with the uniformity of a fixed taper to which the eye becomes accustomed.

You give an allowable unit stress S of 2,250 lbs., and assume the load to come upon one-half the arms of the pulley. This last is, undoubtedly, the true condition, but from extended observation of pulleys and designing a number, it would seem as if a higher figure could be used for S with perfect safety, say about 3,600 lbs.

I know that Unwin gives S as 2,250 lbs., but in so doing he assumes the load to be distributed over all of the arms

In working out the last equation, first column on page 149, there is an error in the result stated. The $ba^2=14$, should be $ba^2=11.4$, and using this last figure in place of 14, gives dimension h at the center of the wheel, 3⅜" instead of 3¾" on an arm assumed to be 1" thick. This with eight arms is manifestly more material than will be needed in the pulley, as will be seen when compared with executed examples, or viewed as laid out on the drawing board.

Regarding the number of arms, why use anything but six arms? This number looks good on pulleys from 1' to 6' in diameter. It co-operates well with driving devices for rotating the pulley while turning, and I believe is used by a large number of pulley manufacturers.

In looking over a catalogue of a leading manufacturer of Molding Machines for pulley castings, it appears that he has used six arms on practically everything in his list, embodying hundreds of spider patterns.

It will save a little time in pulley-arm calculations, and also tend toward uniformity in appearance of a line of pulleys, if the designer will adopt some standard of thickness of arm in proportion to breadth.

For this, the writer frequently uses an ellipse, making the minor axis of same one-half the major axis, and tapers the arms $\frac{1}{2}$" in 12", when viewed in the plane of the wheel. The arms also taper the other way one-half this amount, to preserve the same proportion of ellipse.

The resisting moment of this elliptical section is, approximately, .05 h^3. Some designers, like the Sellers, Prof. Sweet, and others of prominence, prefer the lenticular section of arms as looking lighter. When these are used and the thickness is one-half the breadth h, the resisting moment of the section becomes approximately .04 h^3.

In the matter of thickness of rim, it is well to keep in mind the fact that when used for high speed, pulleys require considerable crowning, and hence, call for a little thicker rim casting.

The company with which the writer is connected has adopted what is believed to be a new system of crowning for pulleys. In this composite system they join the two taper faces with an arc of liberal radius. The combining of these two forms of crowning, (that is to say, the commonly used double taper and the more rarely used arc of a circle) seems to give advantages that neither of them possess singly. The old two-taper system is undoubtedly hard on the center of the belt and the wear which comes at that point of joining is plainly perceptible on the crown of any pulley that has had hard duty upon it.

The pulley with face made up of a single arc, requires quite a thick rim, and hence, the desirability of the composite crowning above described.

Yours truly,

ROBT. S. BROWN.

Not long ago, the master mechanic came into the drafting room, strolled over to my table, and picking up a scratch block, proceeded to sketch a figure with dimensions similar to Fig. 1, and said: "Find the length of X."

I naturally looked at the problem a few minutes, then using my trig. formulae, worked it out in probably ten minutes Mr. Master Mechanic came back with a smile and said, "Did you get it?" When I gave him the answer he said, "Well, let's see if that's right. $\frac{7 \times 11}{7+11} = 2.77$. Yes, that's all right."

It took me by surprise and I resolved

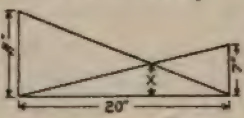


Fig. 1

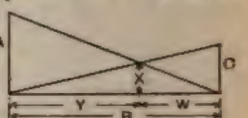


Fig. 2

to find out how such an easy formula was derived. I started by saying, the formula as he used it was

$$\frac{A \times C}{A + C}.$$

Then referring to Fig. 2,

$$\frac{A}{B} = \frac{X}{W} \text{ and by algebra } X = \frac{A\ W}{B}.$$

$$\frac{C}{B} = \frac{X}{Y} \text{ and by algebra } \frac{C}{B} = \frac{A\ W}{B\ Y}.$$

$$Y + W = B \text{ and by algebra } Y = \frac{A\ W}{C}$$

From foregoing equations,

$$\frac{A\ W}{C} + W = B.$$

$$A\ W + CW = BC.$$

$$W = \frac{B\ C}{A + C}$$

$$X = \frac{A\ W}{B} = \frac{A}{B} \times \frac{B\ C}{A+C} = \frac{A \times C}{A+C}.$$

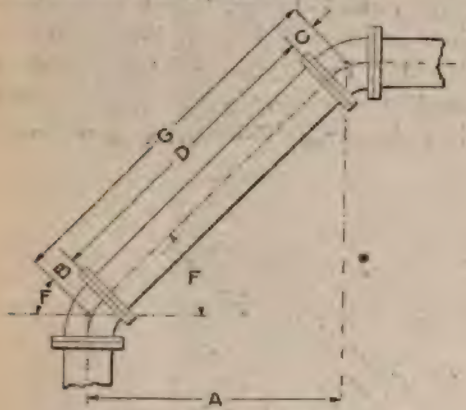
H. McDONALD.

By means of a new "galvano-plastic" process invented in London, plaster, wood, iron, etc., may be encased in copper, the minutest details being preserved in complete individuality under the metal coating.

To Determine the Length of the Hypothenuse.

One of the small problems constantly met with, when laying out pipe work, is the determination of the length of piece of pipe connecting two angle ells, at an angle less than ɩo degrees, says the *Valve World*.

It takes quite a little figuring to arrive at the exact centre-to-centre dimension, if the problem has to be worked out, but by the use of constant multipliers for the different angles the length of the hypothenuse may readily be found, the base of the triangle given.



TO DETERMINE LENGTH OF HYPOTHENUSE

TABLE OF CONSTANTS.

ANGLE F.	CONSTANTS.
$5\frac{5}{8}°$	1.004
$11\frac{1}{4}°$	1.0196
$22\frac{1}{2}°$	1.0824
30 °	1.1547
45 °	1.4143
60 °	2.

Rule—To determine dimension G multiply the distance A by the constant in the table opposite the required angle F.

Example—Assume distance A to be 10 feet and the angle F to be 45 degrees Then ioxi. 4153—14.143 feet which is length of G. From this deduct the center-to-face dimension of the ells, C and B, and the remainder is the length of pipe D without any allowance for gaskets.

A multiplied by constant, minus B+C, equals D.

Union Elbows and Tees (p. 202).

WITH FEMALE UNION

WITH MALE UNION

WITH FEMALE UNION

WITH MALE UNION

A Trough Hopper Intersecting a Truncated Cone.

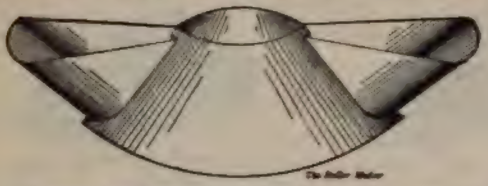
E. J. B.

Though this problem is seldom met with in the ordinary line of laying out, the chances are that some day you may bump up against it when you least expect it, and then the old adage, "In time of peace, prepare for war," proves to be a valuable precept to follow.

The writer of this article had at one time a piece of work exactly on the same lines as illustrated in the picture, and well—he didn't lay it out—it laid him out and the only thing to do was to get it out by the cut and try methods, that is, get it as near as possible, and then cut and fit; but right there and then he determined that he would some day have a better knowledge of how to lay it out should the occasion ever arise. In the development of this pattern, no allowance for the thickness of material, laps or flanges has been made. All these requirements are to be calculated on if anyone has occasion to use this problem.

You will notice in the picture that there are two hopper troughs, one on each side of the cone, diametrically opposite, but in order to save space I show in drawings only what is acually needed, which is ¼

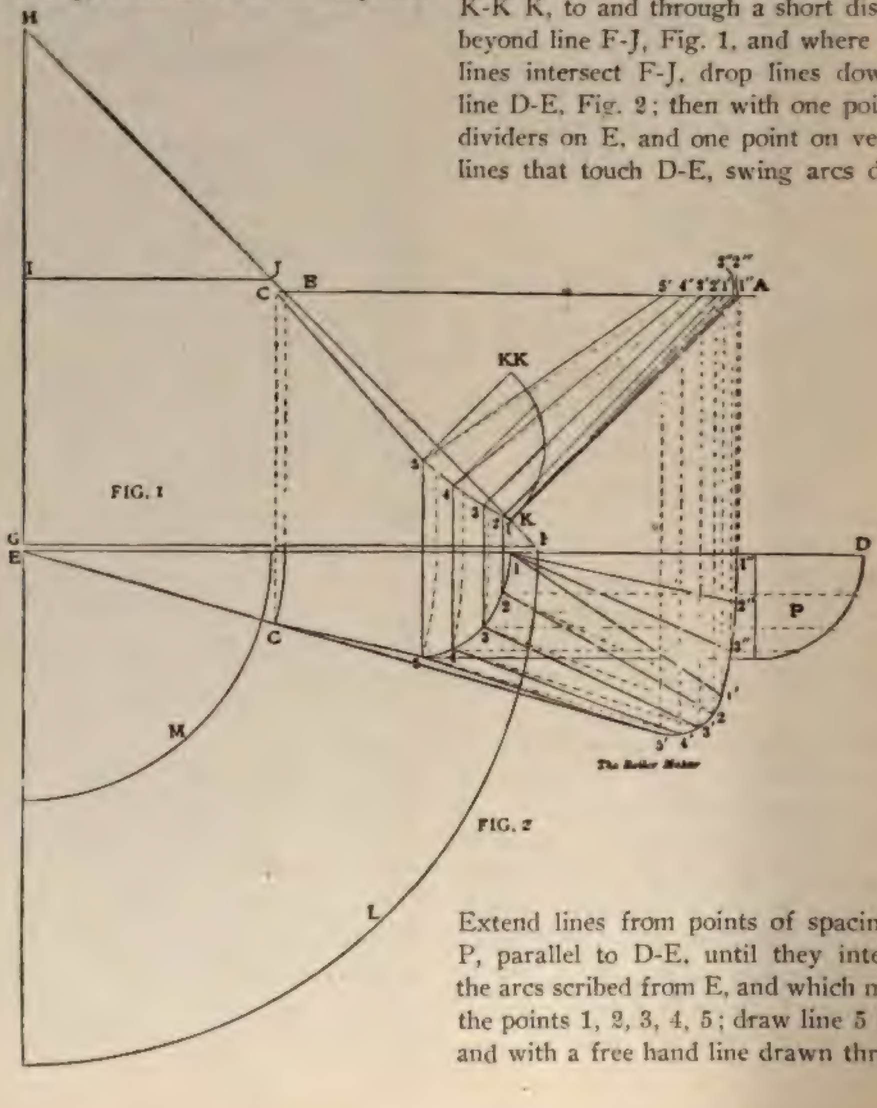
of the cone, with $\frac{1}{2}$ of the trough, plan view, Fig. 2, and elevation view, Fig. 1, and in the development $\frac{1}{2}$ of cone with



TROUGH HOPPER INTERSECTING A TRUNCATED CONE

intersection of trough, Fig. 6, and the whole of one trough, Fig. 5.

First draw Fig. 1 according to outlines F G I H J, make K A B the required pitch and distance from the cone, then draw line D-E a short distance below and parallel to F-G; make the outline 1″ to 1′ to 5′ (notice that 1″ to 1′ is an arc whose radius is E 1″, and that 1′ to 5′ is a short radius), and on to C, and connecting at E′, draw the $\frac{1}{4}$ circles L and M, which outlines the plan view, Fig. 2. Draw the $\frac{1}{4}$ circle K-K K, Fig. 1, at a radius equal to the distance between the line D-E, and 5′-c, Fig. 2; also draw $\frac{1}{4}$ circle P, Fig. 2, the same radius; space both these $\frac{1}{4}$ circles into the same number of equal parts, then drop lines from points of spacing of K-K K, to and through a short distance beyond line F-J, Fig. 1, and where these lines intersect F-J, drop lines down to line D-E, Fig. 2; then with one point of dividers on E, and one point on vertical lines that touch D-E, swing arcs down.



Extend lines from points of spacing on P, parallel to D-E, until they intersect the arcs scribed from E, and which makes the points 1, 2, 3, 4, 5; draw line 5 to C, and with a free hand line drawn through

1, 2, 3, 4, 5, gives you the intersection of the hopper with the cone looking at it from the top downward.

Now in order to get the line of intersection of the hopper on the cone in elevation (Fig. 1), erect vertical lines from points 1, 2, 3, 4, 5, Fig. 2, up to lines extended from ¼ circle K-K K, Fig. 1, also erect vertical line from C, Fig 2, to where it meets line A-B, Fig. 1. We then draw a line from C to 5, 4, 3, 2, 1, and this line is the intersection of hopper with cone; these lines are not the true length, they simply give you location of points for securing altitudes of the triangles, and also assist in securing points for laying out development of the cone.

We will now proceed to secure the triangles for development of the hopper. Draw an indefinite line X-Y, Fig. 3, then X-1 at right angles to X-Y, make X-1 the same height as a vertical height from line A-B to point I, Fig. 1, make the distance 1-1″, Fig. 2, the same on line X-Y, Fig. 3, take the distance of 1 to 2″, 1 to 3″ and 1 to 1′, Fig. 2, and set off on line X-Y, Fig. 3.

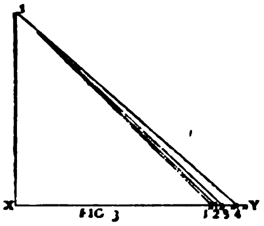


FIG 3

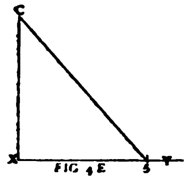


FIG 4 E

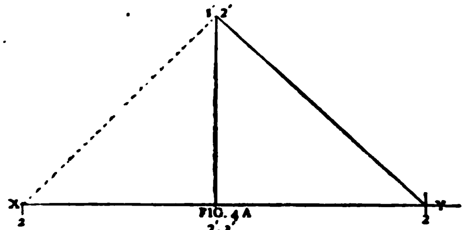


FIG. 4 A

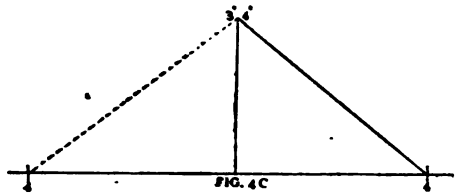


FIG. 4 C

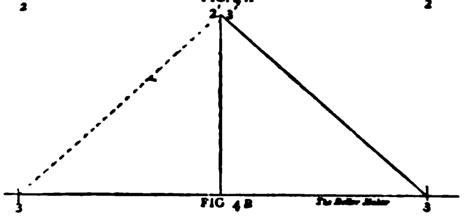


FIG 4 B

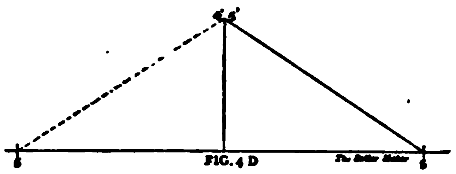


FIG. 4 D

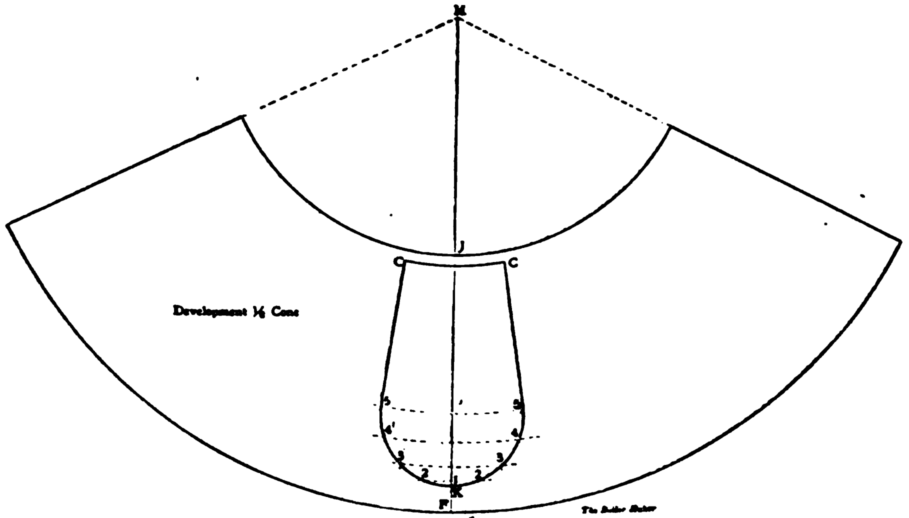


FIG 6

Draw the line X-Y, Fig. 4 A, erect perpendicular height the same as vertical height of 2, to line A-B, Fig. 1, then take the distance 2 to 2′, and 1′ to 2, Fig. 2, and set off on right and left of perpendicular line, Fig. 4 A, and draw full and dotted line as shown. Also draw a horizontal line, Fig. 4 B, and erect a perpendicular line, same height as vertical height from 3 to A-B, Fig. 1. From Fig 2, take distance of 3 to 3′ and 2′ to 3 and set off on horizontal line right and left of perpendicular line, Fig. 4-B, draw dotted and full lines as shown. On Fig. 4 C draw a horizontal line and erect perpendicular to it; make the height the same as from 4 to line A-B, Fig. 1. set off on right and left distance 4′ to 4 and 3′ to 4 from Fig. 2. Make Fig. 4 D, in the same manner, the height being the same as 5 to A-B, Fig. 1, and on right and left set off 5′ to 5, and 4′ to 5 from Fig. 2. The right angle, Fig. 4 E, has a height equal to 5 to A-B, Fig. 1, and X to 5 the same as C to 5, Fig. 2.

The hypothenuse of these angles is the true length of all the correspondingly numbered lines of Fig. 1.

To develop the hopper (Fig. 5) draw the line 1 to 1″ the same as 1 to 1″, Fig 3, space off 1″ to 2″, Fig. 5, same as 1″ to 2″, Fig. 2; take 1 to 2, Fig. 3, set from 1 to 2′, Fig. 5; space off 2″ to 3″, and set off 1 to 3″ from Fig. 3; space 3″ to 1′ and set off 1 to 1′ from Fig. 3.

Now set your dividers the same spacing as ¼ circle P or K-K K; set another pair same as 1 to 2′ to 3′ to 4′ to 5′ on Fig. 2.

(To facilitate explanation we will call one short spaces 1′ to 5′, and the other 1 to 5 long spaces).

First, on Fig. 5, strike long space from 1 to 2, then take 1′ to 2, Fig. 4 A and strike arc from 1′, Fig. 5, cutting 2, then set off short space 1′ to 2′. Take 2′ to 2 Fig. 4 A, and set off on 2′ to 2″ Fig. 5; proceed in like manner striking long spaces, dotted lines, short spaces, and full lines, according to Figs. 4 B, 4 C, 4 D, which brings you up to points 5′ and 5, Fig. 5; then set dividers 5′ to C, Fig. 2, and with one point on 5′ Fig. 5, strike an arc somewhere near C. Now set dividers C to 5, Fig. 4 E, and with one point on 5, Fig. 5, strike an arc cutting arc already struck from 5′, which gives you point C, Fig. 5; draw a line from

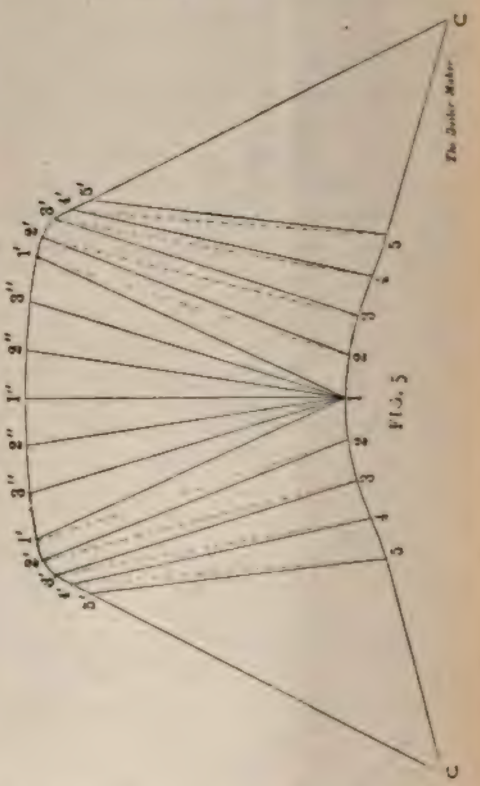


FIG. 5

C to 5′ and C to 5, and with the free hand line drawn through points 5, 4, 3, 2, 1, and 5′, 4′, 3′, 2′, 1′, 3″, 2″, 1″, completes ½ of hopper, Fig. 5, the other half being a duplicate of the one just completed.

The layout of the cone is a simple matter of striking arcs from H to J and H to F, spacing arc F into ½ the full circumference of cone, the diameters of cone being twice F to G. (See Fig. 6.)

To secure the intersection of the hopper with the cone, first draw line H, J, K, F, in center of cone; then with dividers set on H to K, Fig. 7, set this distance off on line H to K, Fig. 6. Set the dividers from H to where line 2 intersects line J-F, Fig. 1, then with one point on H, Fig. 6, strike a short arc 2-2, take off distance H to 3, 4, 5, and C, and set these points on Fig. 6 in same manner as you did 2, 2. Now take the distance on line 2, Fig. 2, from line D-E to the point of intersection 2, set off this distance on each side of line H, J, K, F, on the arc 2-2, Fig. 6. Proceed in like manner to secure the distances from Fig. 2 of 3, 4, 5, C, from line D, E, in same manner and transfer to Fig. 6, then draw a line through these several points and you have the whole layout of the cone.—*The Boiler Maker.*

Two-Thirds Unions Used in Pipe Construction.

There are perhaps many places where a special fitting would be useful in connecting up piping.

Everyone is acquainted with the ordinary union, made of malleable iron in sizes for 1/8" up to and including 4" pipe. In the illustration, it will be noted that there are three parts, a socket piece over which is fitted a nut and the threaded or male end.

There is on the market what are known as *two-third unions*, consisting of the socket piece and the nut and the following table will give the dimensions of the sizes that can be obtained.

It will be seen that the dimension C in Fig. 1 is the same as that for C in Fig. 2, but this need not be so considered, for in designing the neck, it may be just equal to the diameter at the root of the threads.

The dimension G is that taken from the male end of unions now on the market and should be kept as shown so that a lip

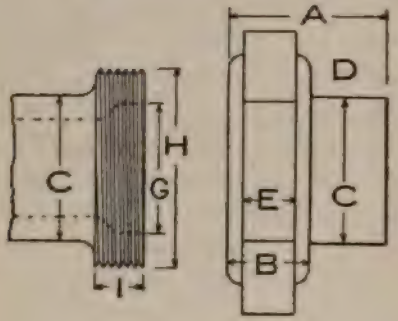
F = dist. across flats of nut. T* = no threads. (See note.) T' from stock.

SIZE.	A	B*	C	D	E	F*	G*	H*	I*	T*	T'
1/8	3/4	25/64	5/8	3/8	3/8	1	31/64	13/16	5/16	14	
1/4	15/16	21/32	5/8	3/8	1/4	1 27/64	37/64	1 1/32	11/32	14	18
3/8	1 1/8	27/32	15/16	7/16	1/2	1 5/8	43/64	1 9/32	15/32	14	18
1/2	1 3/8	27/32	1 1/16	9/16	1/2	1 21/32	63/64	1 3/8	19/32	11 1/2	14
3/4	1 7/16	27/32	1 5/16	3/4	1/2	2	1 5/64	1 21/32	23/32	11 1/2	14
1	1 11/16	1	1 9/16	15/16	9/16	2 3/8	1 9/16	2	13/16	11 1/2	12
1 1/4	1 13/16	1 5/32	1 7/8	7/8	9/16	2 3/4	1 43/64	2 17/32	9/16	11 1/2	12
1 1/2	1 15/16	1 1/8	2 1/8	7/8	5/8	2 15/16	1 29/32	2 41/64	19/32	11 1/2	10
2	2 1/8	1 1/4	2 5/8	1	5/8	3 41/64	2 3/8	3 9/32	5/8	11	10
2 1/2	2 17/32	1 13/32	3 1/4	1 1/8	3/4	4 9/16	2 7/8	4	3/4	8	8
3	2 15/16	1 15/32	3 3/4	1 1/4	7/8	5 1/16	3 1/2	4 1/2	3/4	8	8
3 1/2	3	1 5/8	4 3/4	1 3/8	7/8	5 31/32	4	5 5/16	1	8	8
4	3 1/2	1 5/8	5	1 1/2	7/8	6 5/8	4 1/2	5 15/16	1	8	8

NOTE.—Dimensions marked (*) were furnished by Western Tube Co., Kewanee, Ill. Other dimensions were taken from stock.

on the socket piece will fit into it, without difficulty. The cost of the two-thirds unions is just about two-thirds that of a complete union.

Illustrations are here given of union elbows and tees which are made of malleable iron in sizes for ½" and up to and including 2½" pipe. They can also be secured galvanized, and the dimensions



correspond to those of ordinary malleable fittings.

A combination of a union and a street elbow can be secured in two or three sizes, also a union with male threads on one end and female on the other in a few sizes.

These are listed by Crane Co., Chicago, and Western Tube Co., Kewanee, Ill.

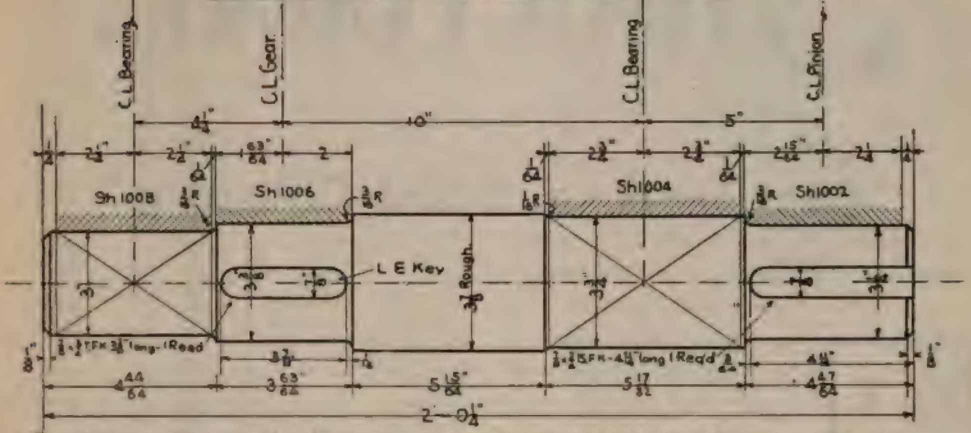
A New Windmill.

The one source of power bestowed by nature on the prairie farms of the country has heretofore proved largely unavailable because of the danger to machinery involved in permitting windmills to run during heavy storms. For a new invention it is claimed it will transmit power not exceeding a predetermined limit, no matter how strong a wind is blowing. This new windmill has two wind wheels with sails oppositely inclined so they will run in opposite directions. As the velocity of the wind increases the wind wheels are tilted upward, thus modifying the force of the wind on the sails. The shaft of the inner wind wheel is hollow and revolves on the shaft of the outer wheel, and the bracket in which the shafts are mounted has a universal joint connection with the windmill standard, an adjustable counterweight balancing the weight of the wind wheels.

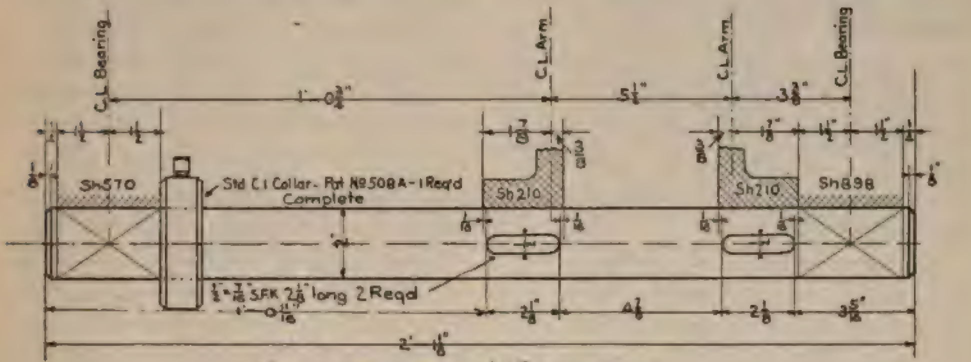
The shafts carry bevel gears at their inner ends, that of inner wind wheel engaging the upper teeth of the power wheel, while the gear attached to the shaft of the outer wind wheel engages the lower teeth of the power wheels. Consequently, although the wind wheels turn in opposite directions, they both act together in driving the power shaft in the same direction. A blade or sail lying adjacent to and below the level of the wind wheels forms the vane of the mill, which occupies a plane normally transverse to the direction of the wind. As the strength of the wind increases the wind wheels rise because of the pressure against this vane and the wheels then rotate at an acute angle to the direction of the wind. In this way the force of the wind on the wheels is modified, for any increase in velocity will be compensated for by an increase in the angle between the axis of the wheel and the direction of the wind.

Manner of Dimensioning Drawings.

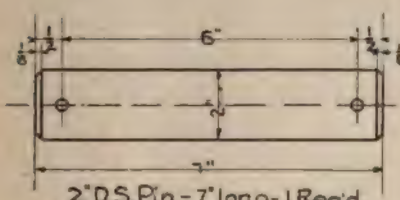
Standard Method of Dimensioning Shafting.



3⅞ S S Pinion Shaft 2'-0¼" long — Finish Except Where Marked Rough — 1 Req'd.



2" D S Brake Shaft - 2'-1⅛" Long - 1-Req'd.



2" D.S. Pin - 7" long - 1 Req'd.
⅜ Split Cotter - 3" lg - 2 Req'd

The above illustration is from the book of standards of The Browning Engineering Co., Cleveland, giving an idea of the manner in which dimensions are desired for drawings. The sheet number is noted in the space to be occupied by the article mentioned, thus giving a clew to the drawing of the other parts, too.

The system is here shown of using dimensions in inches up to and including 12 and feet and inches above, also the mistake of running the dimension line through the figures.

A square foot of uncovered pipe, filled with steam at 100 pounds pressure, will radiate and dissipate in a year the heat put into 3,716 pounds of steam by the economic combustion of 398 pounds of coal. Thus, 10 square feet of bare pipe corresponds approximately to the waste of two tons of coal per annum.

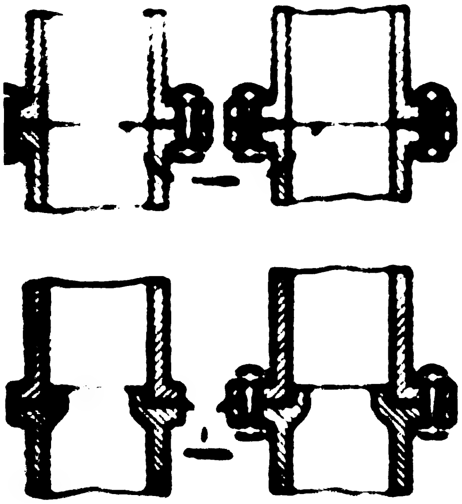
STRUCTURAL.

Cast Iron vs. Steel Columns.

IT would hardly seem that a discussion of the relative values of cast-iron and steel columns need be necessary at the present time, but the repeated use of cast-iron columns in seven to fifteen story buildings shows that the questionable economy of cast columns does still, in the opinion of some architects, compensate for the dangers incident to their use.

The foremost engineers of the country have declared so uniformly, during the last several years, in favor of the steel column that the employment of the cast metal is now pretty generally confined to buildings of very moderate height or to those in which cost has been cut down to the minimum at the expense of safety. The recent collapse of a number of cheap apartment buildings in New York City bears witness to the frequency with which contract work is skimped and building laws ignored. The use of the cast-iron column introduces an unknown factor into the building construction. The great uncertainty as to the uniformity of cast metal long ago led to the adoption of a very low unit stress, while in the case of steel the unit stresses can be assumed on a thorough reliance in the trustworthiness of the metal. Among the successful and well-schooled architects the use of cast iron in large buildings has become a thing of the past, and would no more be seriously considered than would the use of cast-iron compression members in bridge construction.

Considering the cast sections now in general use as columns, we find that the circular, square and the H-shaped are those commonly used. It will be seen at once that these arrangements cannot result in as rigid a framework as the riveted joints in steel work. The columns in modern building design must be capable of affording stiff connections, so as to withstand both the dead load of the building and the live load which may be transferred from one part of the building to another, as well as afford sufficient connections for the wind bracing. Bracing cannot be well secured by means of bolts passing through the horizontal flanges of cast columns, even though the workmanship be considered accurate. As a matter of fact, the work done will seldom even approach perfection. Bolts never completely fill their holes and "shims" are constantly employed to plumb the columns. These constitute elements of weakness which may easily allow of considerable distortion. The girder connections to the columns resting on cast brakes and bolted through to flanges are bad in the extreme, and especially for cases of eccentric loading and to irregular



all about the same. There is seldom any great difference between the costs of the ordinary marketable shapes. The cost of the raw material, however, will practically never determine the relative costs between various column forms, as the expense of the manufacturing, the weight of the columns, the question of simple and complex details and the duplication of members will all influence the ultimate cost to a much greater extent than the simple cost of the unfabricated material.

There are many special columns made, such as the Phœnix, Keystone, Larimer and Gray columns, but all these have the disadvantage of being rolled or manufactured by certain mills only. In consequence the contractor has to await the pleasure of and pay the price asked by that particular mill. The steel work for a building of any considerable size is almost invariably purchased from the mill and the best arrangement as to time of deliveries can be made when the plans call for such shapes as are manufactured by several competing mills and as are handled in stock by the leading merchants. Advantages as to availability are therefore possessed by the columns which can be most readily bought and manufactured, and there is consequently very little difference between any of the steel forms shown in the accompanying illustrations.

In view of the present uniform price per pound of most of the steel sections the items of shop work and workmanship become of far greater importance in the cost of the completed column than the cost of the section at the mill, assuming the sectional area to be the same. The lattice bars, gussets and all such connections add just so much more weight without increasing the section, and therefore must be considered from an economical standpoint. The methods of riveting the sections together in the various forms is a very important consideration in computing the cost. The number of rows of rivets required and the consequent punching operations can be easily figured from the accompanying illustrations.

Columns made of latticed angles or channels are usually limited to very moderate loads in upper stories or in buildings of no very considerable height. The lattice bars contribute largely to the cost of manufacture, as their use requires both shearing to short lengths and considerable riveting.

Columns made of angles and web plates are very satisfactory where the loads do not become so great as to require more than one cover plate. In heavier sections a box column of plates and angles becomes more desirable.

The Z-bar column, without cover plate, requires but two rows of rivets. This simplicity makes it a much-called-for section for buildings of moderate height. As greater loading is required on this section, cover plates can be used to give the desired strength.

The character of workmanship may vary somewhat in the different shapes, as well as with the different sections used. The reputation of the shop, seconded by careful shop inspection, will largely determine the excellence of the workmanship.

As columns carry the greatest loads found in modern buildings, proper fireproofing of these members becomes a most important subject for consideration, and the column best adapted to the fitting in of fireproofing material, such as terra-cotta, tile, etc., has an advantage which should be given due consideration in making a choice.—*Ryerson's Monthly.*

COLUMN SECTIONS.

Fig. 1.—Four angles.

Fig. 2.—Four angles, web and outside plates.

Fig. 3.—I-Beam and plates.

Fig. 4.—Two T-Bars.

Fig. 5.—Two plates, four angles and lattice bars.

I-Beams.

Fig. 12.—Channels and bars.

Fig. 13.—Channels and plates with re-enforcing plates.

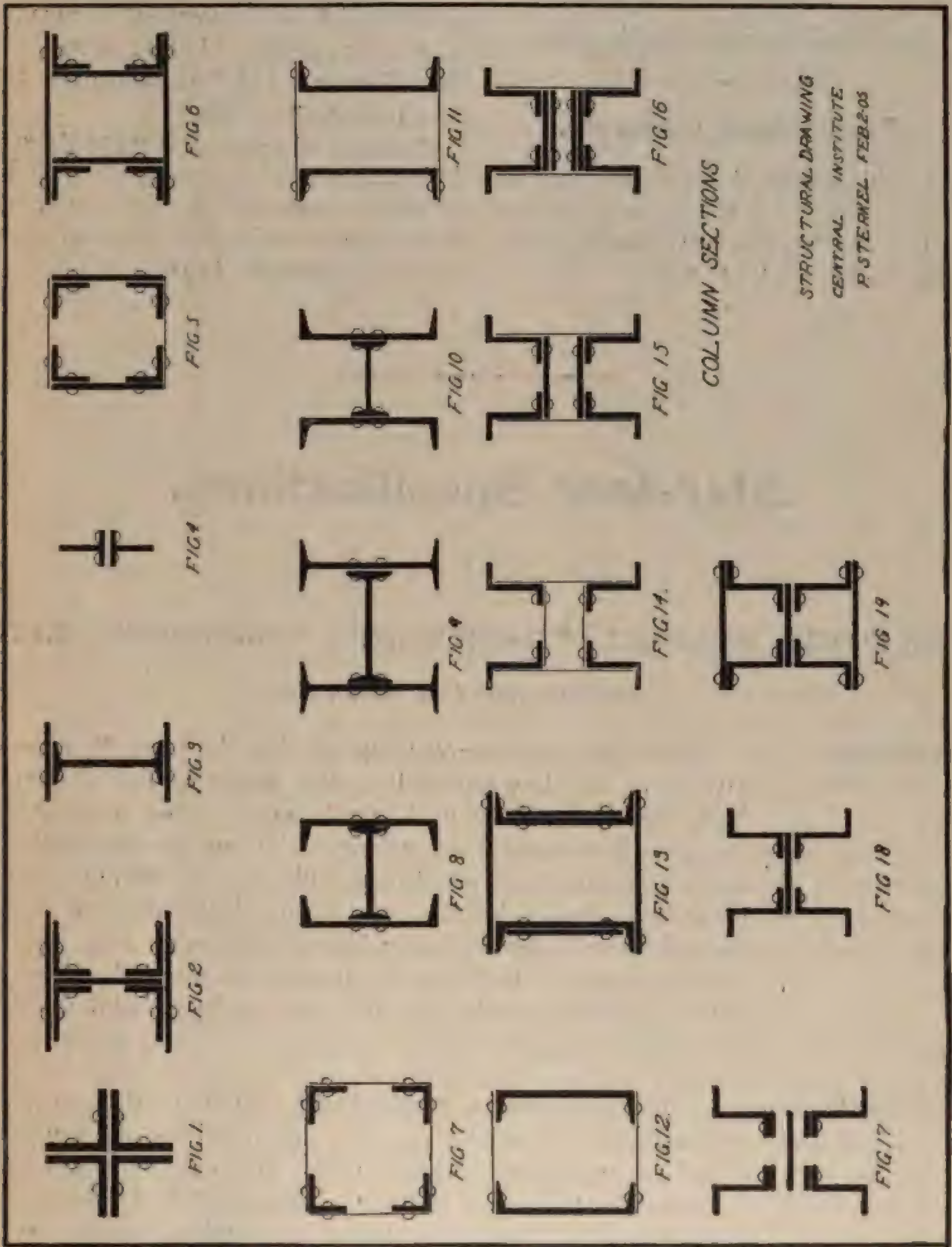


Fig. 6.—Four angles, two web and two outside plates.

Fig. 7.—Four angles, and lattice bars

Fig. 8, 9 and 10.—Channels and

Fig. 14.—Z-bars and lattice bars.

Fig. 15.—Z-bars and plates and lattice bars.

Fig. 16.—Z-bars with double plates

and lattice bars.

Fig. 17.—Z-bars with strips and web plate.

Fig. 18.—Z-bars and web plate.

Fig. 19.—Z-bars and outside plates.

Facts About Concrete.

Crushing strength of 1 cubic inch of concrete is: 2,246 lbs., granite 187 lbs., marble 124 lbs., limestone 108 lbs., sandstone 94 lbs., brick 116 lbs.

Tensile strength of 1 square inch of concrete is 385 lbs.; granite 186 lbs., marble 198 lbs., limestone 165 lbs., sandstone 94 lbs., brick 137 lbs.

The weight of 1 cubic foot of concrete is 154 lbs., granite 184 lbs., marble 170 lbs., limestone 148 lbs., sandstone 140 lbs., brick wall 130 lbs.

Fire test of concrete is 2,100 degrees Fahr., granite 670 degrees, marble 900 degrees, limestone 560 degrees, sandstone 1,400 degrees, brick 1,700 degrees, terra cotta 1,600 to 2,400 degrees.

Standard Specifications.

—FOR—

BUILDINGS, BRIDGES, FRAMEWORK, MACHINERY, ETC.

(*Continued from June number.*)

23. Pins and Pin Holes. Pin holes must be accurately bored to the exact dimensions marked on the drawings and at right angles to line of strain. Particular care will be paid to this point. When a group of members in one panel are connected by one pin they will be bored simultaneously, so that the pin can be readily passed through the hole. All pins must be carefully turned to exact dimensions and properly fitted with nuts, cotters, or other fastenings, as shown. When required, pins will be provided with pilot nuts to facilitate erection, the pilot nuts to be included for the price of the work.

24. Forgings. Where members are provided with loop eyes, said loop eyes will be formed by turning over the end of the bar and welding it back on to the body of the bar with a long weld under a heavy hammer. No welding on of short or stub eyes will be permitted. Eye bars will be formed by upsetting and forging down the eyes. Enlarged screw ends are also to be formed by upsetting.

Unless instructions to the contrary are given before the beginning of the work, all steel which has been forged or worked in the fire will be properly annealed after being forged. All

plates must be bent across the grain of the material, and not parallel with it.

25. Expansion Rollers. Where expansion rollers are called for on the drawings, they will be carefully and accurately turned so that they are all of exactly the same diameter, and the paths for said rollers carefully planed so that a proper bearing is secured.

26. Sheeting. Corrugated steel and iron will be put on in a first-class manner, care being taken that the edges of the sheets are in line so that a ragged appearance is not presented. Where not otherwise marked on the drawings, corrugated iron will be laid as follows: End lap not less than 6 inches, cross lap 1½ corrugates, of 2½ inches each, or 3¾ inches.

Longitudinal seams in corrugated iron to be well riveted with proper sized rivets at intervals of not more than 15 inches. The corrugated iron will be secured to the purlins and girts with hoop iron clips, spaced not more than 12½ inches apart centers, properly riveted at each end. These clips to be generally ¾ inch wide, and of iron at least two gauges thicker than the corrugated iron. Where roofs are covered with corrugated iron the peak or ridge will be provided with a combing or saddle extending not less than 6 inches down each side, well riveted to the corrugated iron at intervals of not more than 10 inches, the combing to be properly lapped and secured at the ends of each section. Edge or eave sheets of corrugated iron will be secured as shown on drawings, with a riveting strip secured to the edge purlins or girt. To this strip the corrugated iron will be riveted at intervals not over 10 inches.

27. Gutters and Conductors. The gutters and conductors will be as shown on the drawings. They will be thoroughly fastened and soldered in position, and the conductors, unless otherwise specified, will be of the corrugated expansion type. They will be of the gauge noted on the drawings.

28. Erection. Erecting is to be done in a most careful and workmanlike manner, care being taken that the framework is erected in truly plumb and proper manner, and all members that are bent or out of line are properly lined up before any riveting is done. All necessary shoring and bracing to properly protect and stay the framework during erection will be provided by the contractor. Joints of framework will be connected either by pins, bolts, or rivets, as indicated on drawing.

(*Continued in August number.*)

HOME STUDY.

Machine Design.

CHAPTER XI.

Tooth Gearing.

IT is not intended that what follows shall be a very elaborate outlay on the subject of tooth gearing but enough will be given to enable the student to lay out a few drawings:

In general the term "gearing" is applied to all parts of machinery by which motion is transmitted: especially is it applied to wheels, whether friction or toothed.

"Tooth gearing" applies to that type where projections on the rim of one wheel fit into grooves in the one with which it is in contact—either may be the driver or driven.

The projections are called "teeth" when they are one and the same piece as the body of the wheel, and "cogs" when they are separate material and fitted into the rim.

The wheels are "in gear" when their teeth or cogs are engaged together and "out of gear" when separated, and the term "gears" will be applied to all toothed wheels.

A "train" of gearing consists of two or more gears "meshing" together, used for a great variety of purposes, such as changing speed or change of direction of rotation of the shafts.

There are many kind of gears, each designed for their particular conditions and duties, and the following is a short description of the principal styles.

Spur Gears are wheels with "teeth" or "cogs" ranged around the outer surface of the rim in the direction of the radii from the center, being all parallel to the axis of the gear and the shafts are also always parallel.

Internal Gears are that class whose teeth, like spur gears, are parallel to their

axis but point in to the center so that they may receive a small gear inside their circumference.

A *Rack* is a series of teeth on a continuous straight line, it may be considered as a spur gear of infinite radii.

Bevel Gears are wheels, the teeth of which are placed upon the outer periphery in a direction converging to the point of the union of the shafts, the latter being at right angles to each other and in the same plane.

Angle Gears are that class whose teeth, like bevel gears, are set at various degrees from their radii, but the axes of their shafts are set at any angle, either acute or obtuse, or in other words, at any angle different from 90 degrees.

Mitre Gears are that class whose teeth are at an angle of 45 degrees from their radii, the shafts being always at right angles and the wheels the *same* size.

Bevel, angle and mitre gears are all similar in action and may be compared to two cones rolling upon each other and the term "bevel gearing" is often applied to the three styles.

As may be noticed, the teeth of the gears will come in contact with the same ones during each revolution of the wheels, and to avoid this one wheel is sometimes made one tooth larger so that the teeth would be hunting new partners in each revolution. This has given rise to the term of *Hunting Tooth Gears*, but it does not usually make enough difference to class them as bevel gears.

When two gears of any type are working together the larger is the "gear" and the smaller one the "pinion." We may have a "gear and rack" or a "rack and pinion."

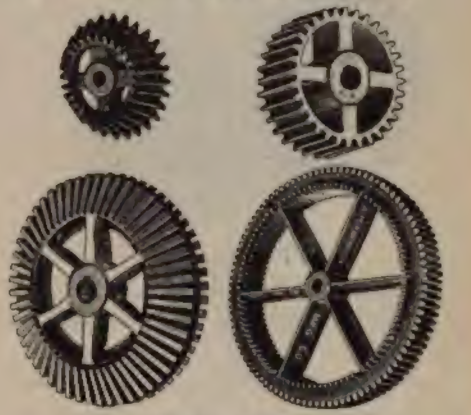
The *"Mortise Wheel"* is one having wooden teeth, called in this case "cogs," set in a cored rim into which they are driven and keyed.

The "cogs" are fitted in place and generally allowed to wear to the proper shape by running with a pinion which is always cast and having teeth rounded considerably at the point.

Mortise gears are really a thing of the past, used mainly in mill machinery when gears could not be cut and when the cast tooth was not even approximately of the proper shape.

They stood the strain well and where subjected to sudden shocks would do far better than a poor cast gear.

A very strong gear is the *Double Helical Gear*, used extensively in rolling mill, hoisting and mining machinery.



Mortise Gears.

They work very smoothly and noiselessly *when properly made*—since the the teeth have always two points touching in the plane of the axis.

Spur gears are made in various forms beside circular, the elliptical being the most common and used for variable speed

Helical Gears.

and quick return motions.

(See page 324 THE DRAFTSMAN of issue of Aug., 1904, for article on Elliptical Gears.)

Spiral Gears are that class whose teeth, or perhaps more properly speaking, threads, are cut or chased at any desired angle to suit the angle of shafts and the required speed.

Twisted and *skew* gearing are other forms of spirals in which the teeth are set at odd angles and the shafts are not

in the same plane.

When shafts are at right angles and the angle on one is so great that it is a *screw* the combination is known as a Worm Gear and Worm and is much used for obtaining slow and powerful motions

Elliptical Gears.

The plain worm gives greater contact at the center line only and less at each end.

All gears are either spoked, webbed or plain, the first two always having hubs while the latter has hub and rim combined.

SPOKED WEBBED PLAIN.

FORMS OF SPUR GEARS.

The spokes are either flat, oval, elliptical, round, T-shaped, or with a section like a cross.

DESIGNING A GEAR.

In designing a gear several factors must be known or if not exactly known must be assumed from what data is obtainable of the conditions under which the gear will have to operate.

The speed is a factor perhaps easiest obtained, then, too, the horsepower to be transmitted may be known, also the size of shaft on which the gear is to be fastened, also the size of gear with which the new one is to "mesh."

Data of this nature would be helpful in beginning the calculations for a gear but some other practical points will be considered as this article progresses.

Since a tooth of one gear must have a corresponding groove or space in the one with which it is to "mesh", the periphery or rim of the gear is divided up into teeth and spaces, measured along a line at about half the height of the tooth.

This line, in the case of wheels, corresponds to the circumference of two solids rolling one upon the other and is known as the *pitch line*.

This is the line of reference in designing gears, and if it is a circle its diameter is used to designate the size of the wheel and the proportions for the teeth and spaces are laid off upon or at right angles to it, depending on the kind of a gear.

The amount allowed along this line for a tooth and its space is termed the *Pitch*, better designated as "Circular Pitch."

Then it will be seen that dividing the length of the pitch line by the number of teeth will give the amount of circular pitch.

The circumference of the pitch circle divided by 3.1416 will give the *Pitch Diameter*.

In stating the size of a wheel, the following dimensions are necessary: First, *the pitch;* second, *the number of teeth;* third *the pitch diameter;* fourth, *the face.*

When designing a wheel, the first three can not be assumed indiscriminately, for the number of teeth multiplied by the pitch must always equal the circumference of a circle whose diameter is the pitch diameter; so, if all were carelessly assumed, the result might be impossible. Neither can the pitch and pitch diameter be indifferently taken, because the relation between them must be such

that the number of teeth is a whole number — as a fractional number of teeth is impossible. The number of teeth and pitch can be taken, however, in any proportion when the pitch diameter is not any particular quantity; also, the number of teeth and the pitch diameter can be used in any proportion, provided that the pitch is not of importance. Regarding the latter case as a consequence, caused by the introduction of a system by which all wheels of the same pitch work together, there are certain standard pitches for wheels as generally made for the market. The standard pitches, commencing with 1 inch, increase in size by *eighths* to 3 inches; from 3 inches to four inches they increase by *fourths*, and from 4 inches and upward by *halves* of an inch. On this account it is best, when possible, to take the pitch diameter of such size that the pitch can be of one of the standard sizes. In Bevel Gearing it is not so important to have the pitch just the standard size, as they are not interchangeable, although for uniformity the standard pitches are usually employed.

The illustration will show the location of the parts of the tooth here described.

The *Face* is the curved part of a tooth, from the pitch line to the point, which receives impulse on entering and imparts impulse when going out of action.

The *Flank* is part of a tooth from the pitch line to the root, which imparts impulse on entering and receives impulse when going out of action.

The *Length* of a tooth is the distance from the root or base to the extremity or point.

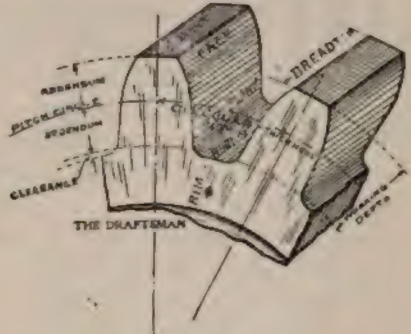
The *Breadth* of a tooth is nominally the "face" of a gear measured along the tooth as shown in the illustration.

The *Thickness* of a tooth is measured at the pitch line.

The *Addendum* is the distance from pitch line to point line, and an equal amount inside the pitch circle is the *dedendum*, then a small amount is given unde the latter for "*clearance*" to the "root."

The "*working depth*" includes only the addendum and dedendum of a tooth, for that is the only part really in action.

The "line of centers" is a line drawn from the center of one gear to the center of another when their circumferences touch each others; in other words, the pitch lines of two gears in action touch on the lines of centers, and from that



Tooth Parts.

point to their centers is the radii of the gears.

The circular pitch is shown as the distance from center to center of two consecutive teeth.

Diametrical pitch is a term used to express a relation of the number of teeth to the *pitch diameter*; that is, a ratio of teeth to diameter and is found by dividing the number of teeth by the pitch diameter in inches, in other words, it gives the number of teeth for each one inch of the diameter.

If a gear had 40 teeth and a pitch diameter of 10 inches then the diametrical pitch would be 4, and this would be expressed as a 4-pitch gear.

The diametrical pitch may contain a decimal; for instance, a gear of 35 teeth and of 12 inches diameter would be a 2.966-pitch gear.

ILLUSTRATING.

Newspaper Cartoons.

H. W. WILLIAMS, Haverhill, Mass.

THE word cartoon stands for a subject so well known to every reader of the daily paper that it is hardly necessary to give any explanatioh of its derivation or trace its rise through the successive years.

We are not, at the present time, interested in the history of the subject but how to make drawings. It seems advisable to divide the subject into a number of lessons, of which this is the first, and to assign certain work in connection with each lesson.

Coming now to the practical side of the actual making of a cartoon for publication in the public prints, we must thoroughly appreciate that a cartoon is first and foremost an idea or a series of ideas. Back of every cartoon of any force there must lie some vital and timely thought.

A cartoon is merely the expression of an editorial, a bit of news or some interesting facts presented, not by letters, but by lines. To be successful in its mission a cartoon must be so drawn that its story can be easily read by him who runs.

There are two distinct divisions that should be made under the general topic —cartoons, and these are the political cartoon and comics. Both of these are much the same in their general formation, though the one is strictly serious, the other humorous.

Therefore, the topic having been chosen, the next step is to picture the scene in the mind. All this has to be done without any drawing. Then having once imagined the picture, we come to the actual drawing of it, which has to be done largely from memory.

Just as the actor is obliged to memorize the various plays in his repertoire, so the cartoonist has to commit to memory the various figures necessary to the expression of his ideas in pictorial form.

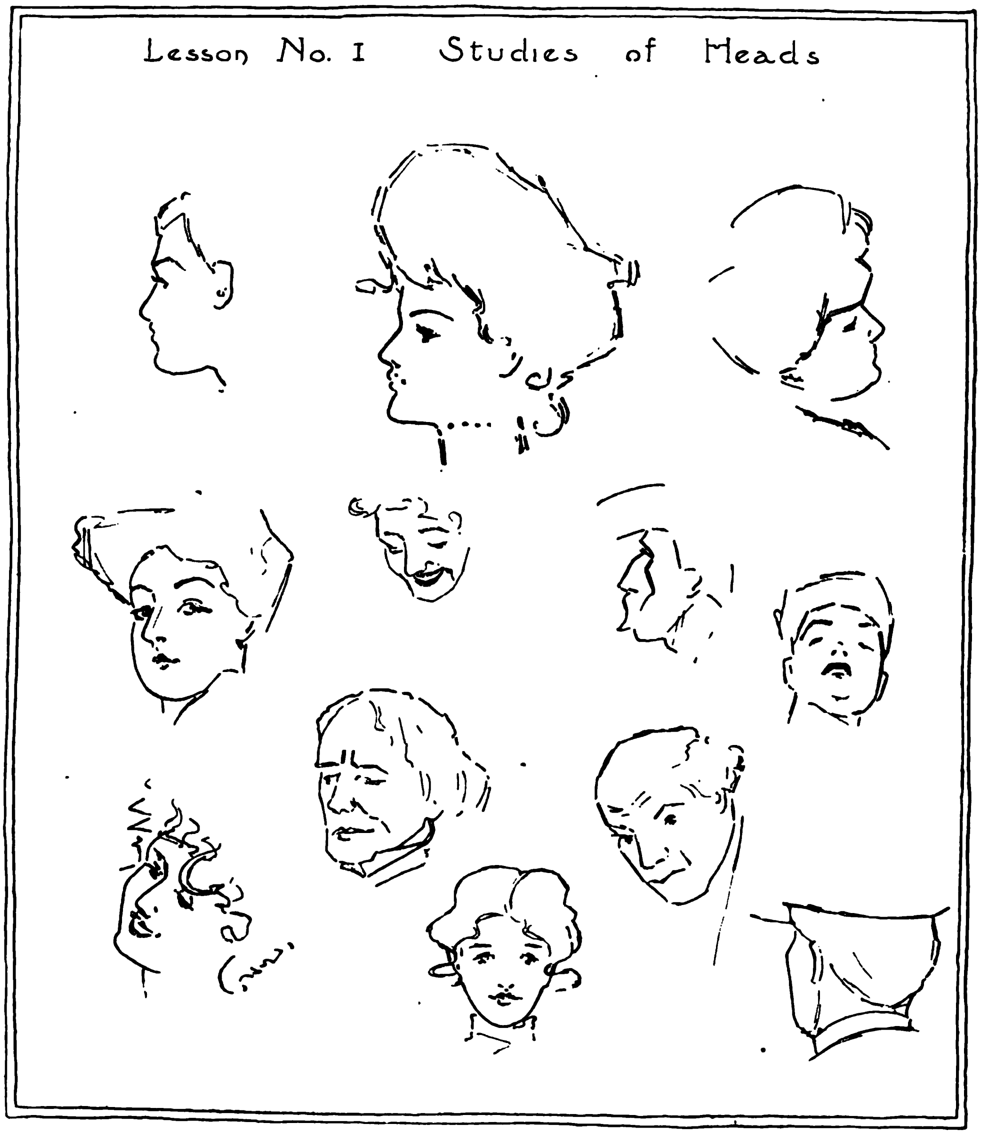
Of the technical qualities to be cultivated the most essential is that the drawing be very free and bold, while the figures and faces should be expressed in the fewest lines possible. Any line in the drawing of a face that is not absolutely necessary to express the position or expression should be eliminated.

The difference between a cartoon and a picture is that the latter appeals to the public because of its beauty of color, its appeal to the senses or its power of recalling scenes long since passed. The cartoon, on the other hand, does not ordinarily possess any of these attributes; its function is more utilitarian. Its value lies in its power to present an easily-sensed line of thought in such a way that the whole situation may be seen at a moment's glance, the verbal description of

which would consume column after column.

The technic of the subject can not be too forcibly insisted upon. All unnecessary lines or embellishments must be left to the picture-maker.

ance. To a person of naturally vivid imagination the process of picturing a certain scene in the mind is not a difficult matter and memory is one of the greatest aids in this process. The student cartoonist, who has a good



In the imagining of the action before it is put on paper a large part of the difficulty lies. The cultivation of this particular faculty is of the utmost import-

stock of pictorial images, will have no difficulty in arranging them to express the story.

In considering the importance of these

memorized forms the first would be the human face. Therefore, the first lesson will be devoted to studying the face especially as regards the different positions in which it can be placed. The student cartoonist should be able to draw from memory a head in the following positions: Front, back, side and three-quarters views, tipped forward and back, and foreshortened in various ways.

Plate I. gives some suggestions for study in this particular. In studying these heads it is suggested that the student copy one of them a number of times, close the book and then try to reproduce it from memory. Familiarization with the various positions is indeed necessary and if the cultivation of the ability to express such positions in as few lines as possible is attempted, the first steps in newspaper cartooning will have been well taken.

Taking into consideration the course of study through which a person would have to go in order to become a skillful worker at this trade, it seems not improbable that the process would be similar to the training any other skilled artisan has to have.

The writer of stories has to serve a long apprenticeship before he becomes an expert at his work. In following his studies he has to learn first the significance of a large number of words and phrases, to understand the rules of grammar and then to have an extensive acquaintance with the works of standard authors. To put it more briefly, his effort is to gain control of the tools of his trade. The student cartoonist has to do the same thing, he has to gain control of the tools of his trade, and these tools are the study of the head and of the figure both human and animal. Characteristic movements and attitudes, such as leaping, running, standing, sitting, rowing, mowing, etc., must be carefully studied.

Following this would come the study of the rules of simple perspective, composition and the study of the effect of the modern processes of reproduction. This includes pen and ink work and wash drawings.

Perspective includes a knowledge of the use of the horizon line, vanishing points, control of vision, and measuring points. The subject of vanishing edges is a very important one in many cases. It is particularly useful in drawing streets, houses, bridges, railroads and in general to give the effect of distance.

Composition takes up the grouping of the masses of a picture and brings in the laws of space relation, variety and center of interest. It is really a difficult matter to work out a reasonable grouping for a large picture and very often designers avoid this difficulty by having a central theme with a number of minor objects grouped about it.

Mr. Williams will be pleased to answer questions and give criticisms on drawings provided return postage is enclosed.

Under no circumstances whatever will the publisher or Mr. Williams hold themselves responsible for the safe return of either drawings or letters.

Address all communications to H. W. Williams, 44 Arlington St., Haverhill, Mass.

PATENT DRAFTING.

Applying for a Patent.

IN order to apply for a patent it is necessary to file in the Patent Office at Washington, D. C., a Petition, Affidavit of Invention, Drawings, and Specification, all of which must be prepared in legal form and in accordance with official rules and practice of the office.

This can best be done by a reliable attorney but an applicant should understand some of the requirements, too.

The Patent Office does not require a model to be furnished in order to apply for a patent, but if the attorney is not near enough to see the one made by the inventor, then one should be sent him unless good photographs and drawings can be supplied.

Since the drawing attached to the specifications and claims is to be on a special size sheet, no attention need be paid to having the original sketches of a uniform size. When ready to apply for a patent secure as much evidence of the reliability of some attorney you have heard of and consult him about the matter, explaining as much as necessary so he can prepare an outline enough to permit a preliminary search being made of the records in the Patent Office to see that no interference will take place should the application be made.

This usually costs $5.00 and an attorney often supplies copies of existing patents that look the least like the one in question.

If it is thought that there will be no interference, the case is then prepared for the examiners and the application duly made.

The drawings should be made and lettered so that the specifications can be written up including the proper reference to the different parts.

The drawings should be made upon paper stiff enough to stand in the portfolios, the surface of which must be calendered and smooth.

The best is patent office bristol, there being a style on the market printed with margin and headings all ready for use, though the surface is not of the best.

The size of a sheet on which a drawing is made should be exactly 10x15 inches with margin lines one inch from all edges, leaving a clear space of 8x13 inches.

One of the smaller sides is regarded as its top and measuring downward from the margin or border line, a space of not less than $1\frac{1}{4}$ inches is to be left blank for the insertion of title, name, number and date which is put in by the patent officials.

All drawings must be made with the pen only, using the blackest India ink

Every line and letter, including the signature must be *absolutely black*.

This applies to all lines, however fine, to shading and to lines representing cut surfaces in sectional views. All lines must be clean, sharp, and solid and they must not be too fine or crowded.

Surface shading, when used, should be left very open. Sectional shading should be by oblique parallel lines, which may be about one-twentieth of an inch apart. Drawings should be made with the fewest lines possible consistent with clearness, for the drawings are subjected to photographic reduction which decreases the space between the lines.

Shading (except on special views), should be used only on convex and concave surfaces, where it should be used sparingly and may be dispensed with if the drawing is otherwise well made.

The plane on which a sectional view is taken should be indicated on the general view by a broken or dotted line.

Heavy lines on the shade sides of objects should be used except where they tend to thicken the work and obscure the reference letters.

The light is always supposed to come from the upper left hand corner, at an angle of forty-five degrees.

Imitations of wood or surface-graining should not be attempted.

The scale to which a drawing is made ought to be large enough to show the mechanism without crowding, and two or more sheets should be used if one does not give sufficient room to accomplish this end; but the number of sheets must never be increased unless it is absolutely necessary.

Sometimes the invention, although constituting but a small part of a machine, has to be represented in connection with other and much larger parts. In a case of this kind, a general view on a small scale is recommended, with one or more of the invention itself on a much larger scale.

Letters or figures may be used for reference, but they should be well made, and when at all possible should not be less than one-eighth of an inch in height, that they may bear reduction to one-twenty-fourth of an inch, and they may be much larger when there is sufficient space.

Reference letters must be so placed in the close and complex parts of drawings as not to interfere with a thorough understanding of the same and to this end should rarely cross or mingle with the lines.

The illustrations on pages of current topics under head of new patents shows the manner of putting in the reference lines from the letters to the part indicated.

As is seen, they are carried out some distance, but if placed on the face of the object where sectioned, a blank space should be left in the shading for the letter.

If the same part of the invention appears in more than one view, it should always be represented by the same letter.

Great care should be exercised in the matter of drawings, or they will be returned to the applicant, but at his suggestion and cost the officials will make the necessary corrections.

One of our data sheets this month is a chart for draftsmen as recommended by the Patent Officials.

Civil Service Examination.

The United States Civil Service Commission announces an examination on July 19-20, 1905, to secure eligibles to fill a vacancy in the position of draftsman in the office of the surveyor-general at Phenix, Ariz., at $4 per diem. In applying for this examination the exact title, "Draftsman, Land Office Service," should be used.

CURRENT TOPICS.

Push On.

If you have a job worth keeping,
Just push on ;
Some one for it may be seeking,
So push on.
Work the very best you can,
Better than the other man,
You will find it the best plan
To push on.

If your brain you nearly rack,
Just push on ;
With a nut hard to crack,
Just push on.
Tho' your head begins to thump,
And you think you're up a stump,
Just work hard and get a hump,
And push on.

Do not think it's all in vain,
But push on ;
For success you'll surely gain,
So push on.
And things will come your way,
You will have a winning day ;
Take advice,—mind what I say,—
And push on.
—A PENCIL PUSHER.

The civil engineers are holding a convention in Cleveland, June 20-24. Much of the proceedings of the meetings will have to go over to our August issue.

Our address is on the first right-hand page inside the cover, a convenient place, we think, but we occasionally get orders addressed to the Universal Drafting Mach. Co. These, of course, are sent to us, for there is no connection between the two concerns.

It will be noted that our issues are coming out near the first of the month, we are very glad of it, even if the mail is not so full—of kicks.

We believe it will be heavy with othe things, there is a steady increase of subscribers.

As will be seen in this issue the supplements are attached to the magazine, but ruled the 6x9 size so you can trim them down.

It has been found that in a few cases the supplement was overlooked in sending out copies later than at the regular mailing time, and we take this method to insure a complete number.

Simply lift the staples in the middle of the magazine and remove the sheet, then press down the wires again. Then, too, the sheet will not be ragged or torn at the edges, when enough margin is given to trim.

Many plans have been devised to bring more persons in touch with our magazine but the latest is the best—for the subscriber.

Circulars and coupons are now being sent to all subscribers, and their co-operation solicited, the plan and list of prizes being outlined.

The coupons you are to sign and pass over to some one interested and as they are returned to us we credit you with each received with your name thereon. The prizes are worthy the effort and cost you nothing except a little work.

If you are not a subscriber send in your name for a four months trial for 25 cents and ask for lists and coupons.

The contest will close Oct. 31, 1905, and the results will be noted in the December issue of THE DRAFTSMAN.

It has always been a surprise to us why persons send in an order through a news dealer, when they have the address of the publication themselves. A great number of publications have premium offers which they allow for new subscribers, but which they do not care to give if they have to pay a commission to the dealer.

Of course, when an agent solicits the subscription, works hard to get it, he deserves a commission, but it looks rather queer to have a subscriber ask for a premium, too. Don't do it, if the agent hands you a copy for the first time and talks up the advantage of the magazine, and you can give him the order and let him earn something and allow the poor publisher to live, too.

If you want a premium, don't favor the agent, especially when you can send in the order yourself and when you have a copy direct from the publisher.

We were much interested in the article, "Why not Organize" in the June issue. There is quite a feeling among the pencil pushers to form a society of some sort, and the columns of THE DRAFTSMAN are always open to expressions on this subject.

One thing in our mind is this, there will always be need of some strong members in each city to hold the society together. The matter should be thrashed out in these pages, then a plan published. As soon as possible we will suggest some forms to be used in the organization and committees can be appointed at various places to bring the men together and explain the plan.

We are in receipt of a list of names of draftsmen, from Mr. A. B. Hayes, Milwaukee, Wis., for which we feel grateful.

If each of our readers took that much interest, this magazine would reach every draftsman in the country.

Why Not Organize?

As a pencil pusher I have been very much interested in the several contributions submitted lately regarding a draftsman's fraternal organization.

I am in hearty agreement with the plans submitted by "A Pencil Pusher," in the June number of our magazine, although I do not think he makes himself very clear in regard to the examination for admittance to the society.

I would suggest an examination consisting of questions to determine whether the applicant is a practical draftsman; whether his moral character would reflect credit on the organization, and to ascertain his willingness to support, enforce and be governed by the existing rules and regulations. The examination should not be too rigid or elaborate, as it would involve too much expense and labor. It would also have a tendency to discourage many young draftsmen from applying for admission.

I am convinced by my own experience that the young draftsman is the one of all others who is in need of advice and aid in bettering his condition.

My endorsement goes with every effort made to help one another, either into a better position or to help any who might be disabled on account of sickness or accident.

We might make arrangements with our editor for a Question Department in THE DRAFTSMAN, which would increase the interest of all concerned.

As already suggested, the benevolent department would be no small feature of the society's activity.

I have been for a few years closely connected with a very successful mutual

The B-Pad Puller

Bill and the Billboard

New Inventions

A. These margin strips project above the upper face of the back A, forming a recess b into which fits the cork facing B, as is readily apparent from the drawings.

Fig. 1.

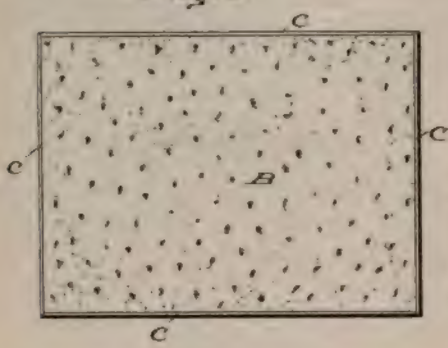


Fig. 2.

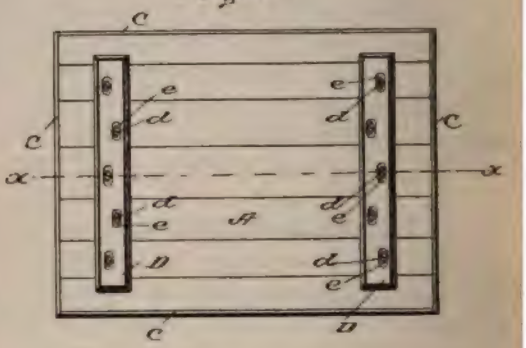


Fig. 3.

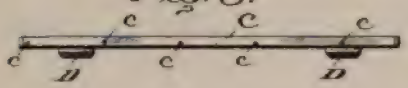


Fig. 4.

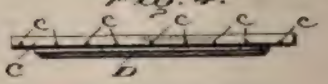
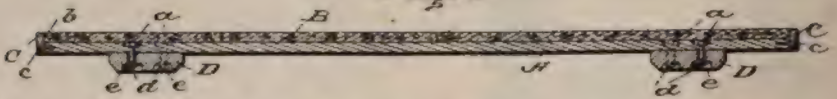


Fig. 5.

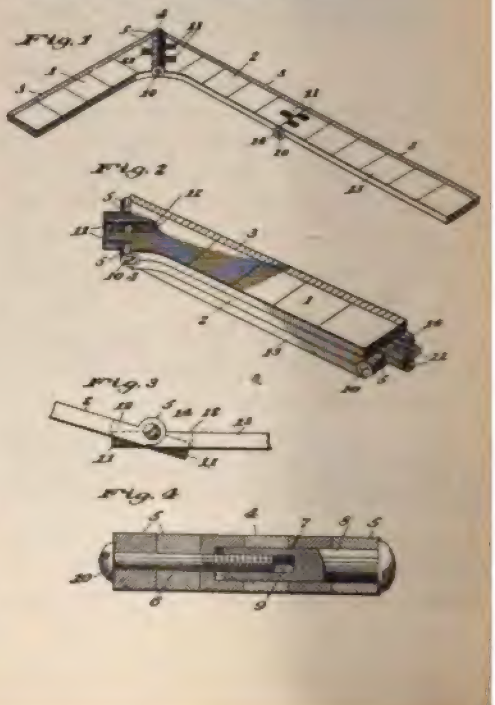


Upon the end face of the back A there is secured a pair of supporting members D, which consists of rectangular strips of any desired thickness extending transversely across the bottom of the board, which serve to lift it above whatever object it may be placed upon when in use. These strips D have openings e therein, which are adapted to receive securing members or screws d, which engage nuts or other suitable hold-fast devices a, seated in recesses formed in the upper face of the backing A, and securely hold the strips of said backing together.

SQUARE.

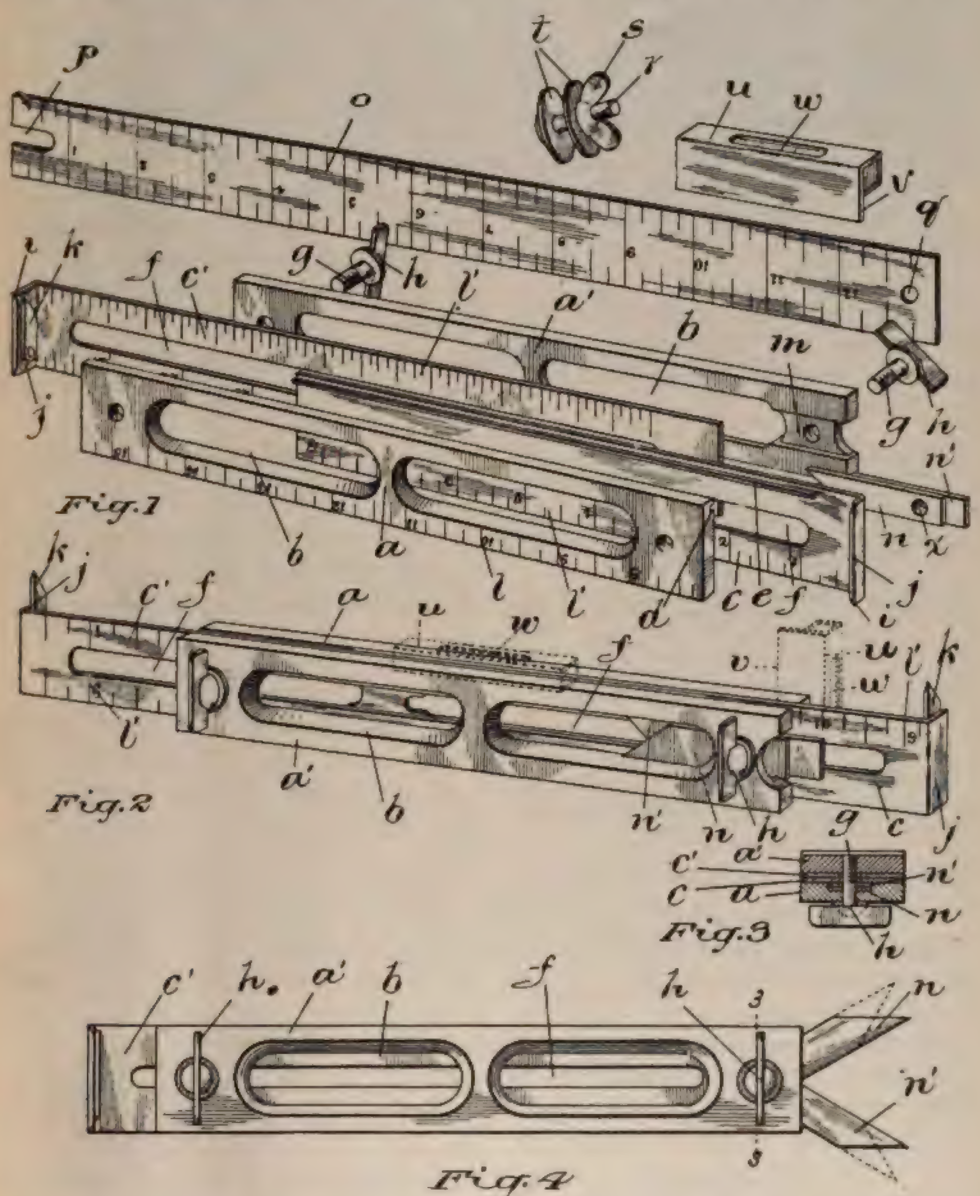
No. 787,248—Generous Wilson, April 11, 1905. The object of this invention is to provide a square of the general character shown of a strong and durable construction which shall be capable of being compactly folded up, so as to occupy a small space when not required for use, so as to permit of being more conveniently carried about than are such squares as ordinarily constructed with rigid or non-folding arms.

The construction of the instrument is obvious from the illustration.



COMBINATION TOOL.

No. 787,172—George E. Hasson, April 11, 1905. This invention consists in a multiplicity of parts that are adapted to



be fitted to one another in different relations, so that the occasional omission of an element or the addition of it in a different position will combine to form different tools and instruments such as squares and similar instruments of precision.

The device is adapted for use as a compass, a square, a T-square and various other similar instruments.

Give most men a good listener and most women enough note paper and they will tell you all they know.

BOOK REVIEWS.

The fifth edition has appeared of "Manual for Engineers," published by the University of Tennessee, Knoxville, Tenn. It has been published from time to time with its real object to increase the interest of men of affairs in technical training.

These books, which are 2½x5½" leather bound, contain many tables and other data for engineers and business men.

In all, there are 230 pages of matter such as found in the engineer's hand books, but in a neat and compact form.

"Practical Wood Carving," is the title of a new book by Mr. Fred. T. Hodgson, the well-known writer on subjects, and bears his stamp—simplicity—in its make-up.

It is well suited to the needs of carpenters, joiners, amateurs and professional wood carvers, being a guide to all kinds of wood carving.

There are over two-hundred illustrations, diagrams and designs in the 275 pages, and these are clear and of good size.

The lessons in this book commence at the very beginning of carving and lead the young worker by easy steps through the mazes of the art until he is able to do good work.

The book is well bound in cloth with gold title, price $1.50, and published by Frederick J. Drake & Co., 211 E. Madison, Chicago.

A new periodical has appeared entitled *American Carpenter and Builder*, from Chicago.

It is the regulation size, 9x12, and contains much matter of interest to the carpenter and builder.

To black small articles of polished brass: Make a strong solution of nitrate of silver in one dish, and of nitrate of copper in another. Mix the two together and plunge the brass into it. Now heat the brass evenly until the required degree of dead blackness is obtained.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Ribbing of Fly-Wheels and Pulleys.

IN the article on Mechanical Designs in the May number of THE DRAFTSMAN there were illustrations of several forms of rims for belt wheels. I would like to call attention to a few points in regard to the form of rims that I think will be of interest to draftsmen. The rim sections shown in the above named article are such as are given in most text-books on machine design, but they are carefully avoided by good designers at the present time.

The condition of a pulley rim under the action of centrifugal force is that of a continuous beam uniformly loaded. It is held in at the arms and bulges out between them. This places the greatest strain on the inner side of the rim near the arm. Now if there is a comparatively light rib on the inside of the rim, as shown in Fig. 2, or if this be separated into two ribs and placed at the outer edges, as in Fig. 3, the greatest strain will come at the inner edge of the web where there is the least amount of metal to resist it. Consequently small cracks are liable to start at these points. If the cracks only extended through the rib, the rim would be slightly *stronger* than before, but when a crack is once started in cast iron it will continue to "creep" slowly, and the result is apt to be another disastrous belt wheel explosion.

I do not mean to say that wheels can not be ribbed to advantage, but care should be taken that they are not ribbed in such a way as to weaken them.

Let us consider the particular case of a rim 24" face and 2" thick (Fig. 1). The section modulus $\frac{bd^2}{6} = 16$. Now suppose ¼" be taken off the lower side and made into a rib at the center as shown in Fig. 2, or that it be divided and placed on either side, as in Fig. 3. The section modulus can be easily computed from common formulæ which may be found in the Cambria Hand Book, and is 11.8. Hence this rim is only about ¾ as strong as before.

Now suppose we make the rim 1¼" thick, and place the metal thus removed into a rib at the center 1¼" x 14⅜". The cross sectional area is the same as before, but the section modulus is increased to 78.6. Therefore Fig. 4 is

nearly five times as strong as Fig. 1, and more than 6 1-2 times as strong as Figs. 2 or 3. Thus it will be seen that a proper distribution of metal in a rib is a great advantage. It is also an advantage in casting, as the rim and web are of the same thickness and will therefore cool evenly, thus avoiding as much as possible the cooling strains.

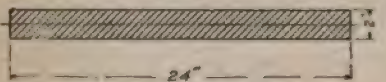


FIG 1

FIG 2

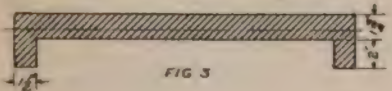


FIG 3

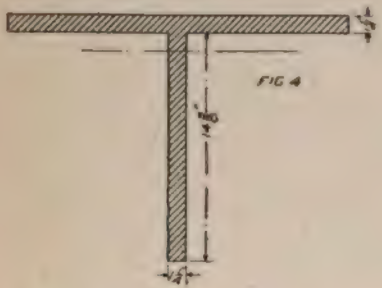


FIG 4

Another point that may be considered is that midway between the arms the rib is in compression, and as cast iron will stand considerably more in compression than in tension, the height of the rib may be reduced at this point, as shown in Fig. 5. It will be found that to be of uniform strength it should be about 5/8 as high here as near the spokes.

H. M.

Curves for Shaft Deflection.

The accompanying curves are to assist in determining the size of shaft necessary to carry a given weight, the distance between supports being known.

The curves numbered 1½, 1¾, 2, etc., to 10 represent shaft diameters, and are plotted from the formula:—

$$\frac{W L^3}{48 E I} = .01$$

which is the formula for the deflection of a beam, supported at the ends, with a load at the middle, allowing .01" for the deflection. In the general formula there are so many variables that it is impossible

FIG 5

to plot a curve or series of curves to cover all cases, so it was necessary to eliminate all but two factors. This is done by plotting one curve for each diameter of shaft, and placing the deflection equal to .01". This value was chosen because it is the maximum allowable in certain work. E is the modulus of elasticity, and for the material used, 28,000,000 is the proper value. I is the moment of inertia equal to

$$\frac{\pi r^4}{4}$$

for a beam of circular section, r being the radius.

Substituting these values in the formula given above, we have:—

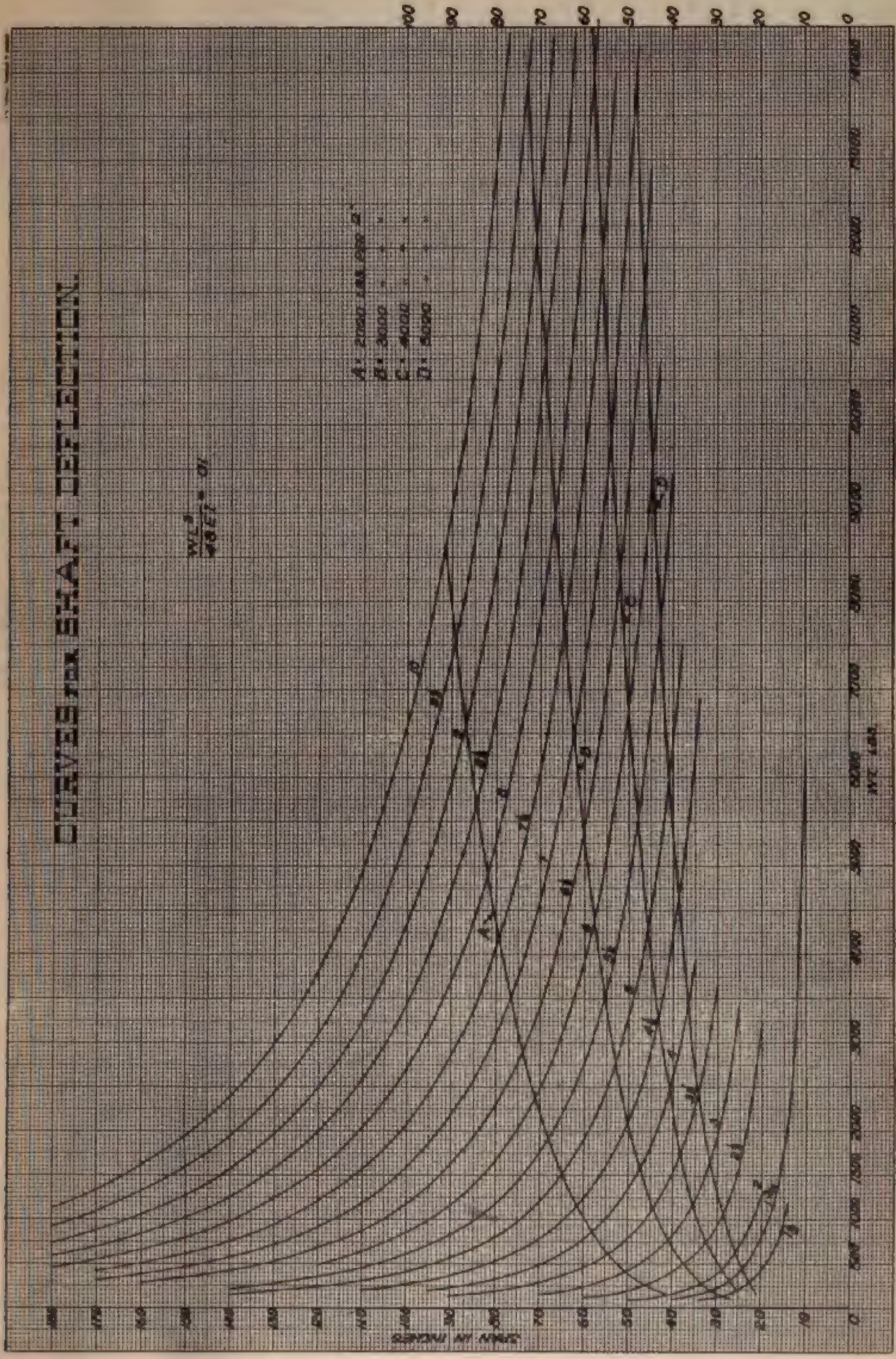
$$\frac{W L^3}{48 \times 28,000,000 \times \frac{\pi r^4}{4}} = .01 \qquad (a)$$

This may be reduced to

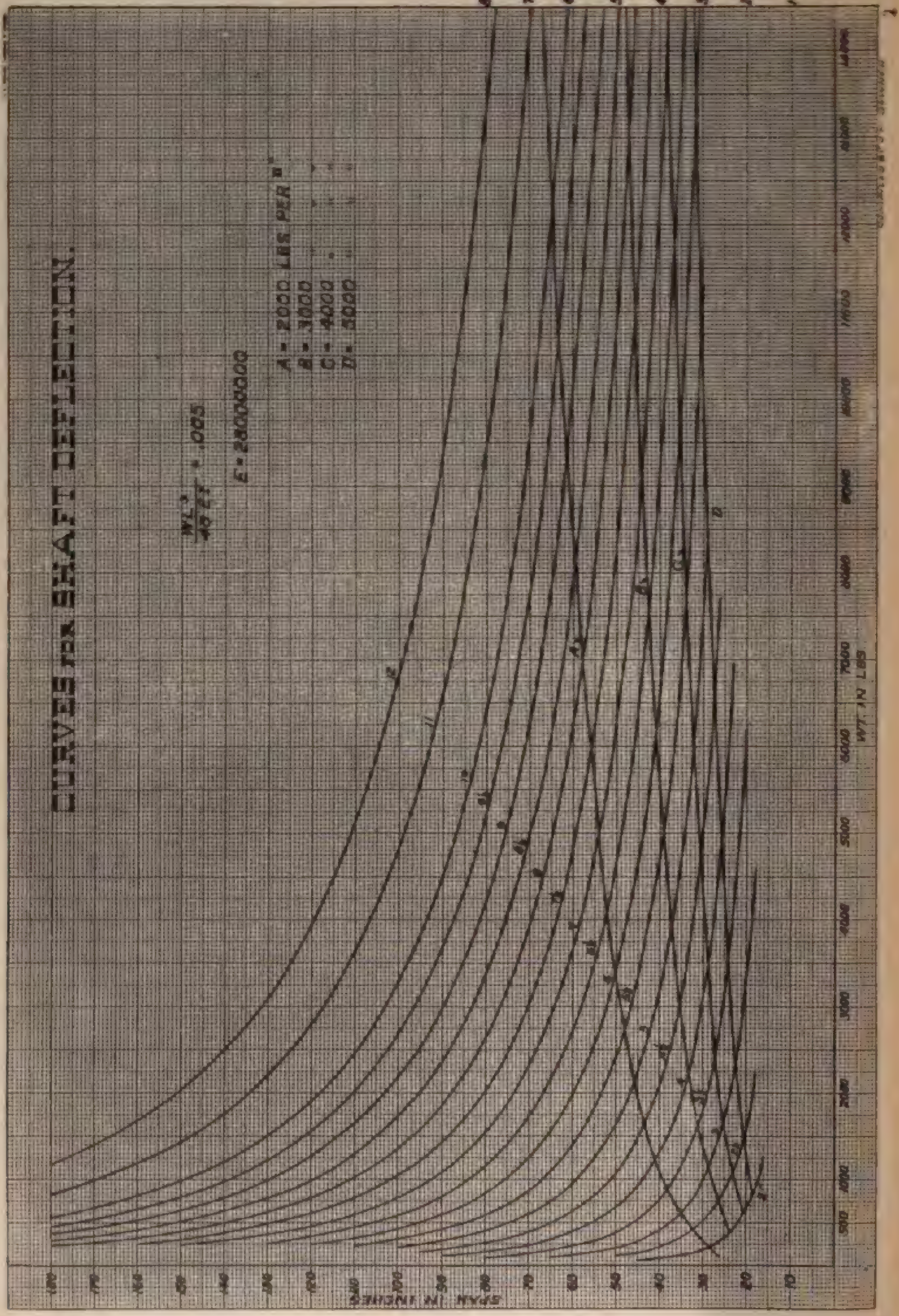
$$W = \frac{10,560,000 r^4}{L^3} \text{ nearly.} \qquad (a^1)$$

(The actual value of the constant is 10,555,776, but the other value is near enough for practical purposes, and gives values as nearly correct as it is possible to read the curves.)

To obtain the figures for the curves different values are assumed for L, which



Curves for Shaft Deflection.



Curves for Shaft Deflection.

corresponds to the "span in inches" on the curve sheet and for the different sizes of shaft solved for W, the weight in pounds which that diameter of shaft would sustain at its middle point with a deflection of .01 inch.

It is readily seen that for a given shaft and a constant deflection that the fibre stress will increase as the distance between supports decreases. In any case it is necessary to keep the stress within safe limits. In order to determine approximately what the stress is for the different conditions of load and span, the curves "A," "B," "C" and "D" were plotted.

The fibre (maximum) stress in a beam supported at the ends and loaded in the middle is:—

$$f = \frac{Mr}{I} \qquad (b)$$

where r and I have the same significance as before, and M is the bending moment, equal to $\frac{W\,L}{4}$.

Wherever the curve marked D intersects the shaft curves the fibre stress will be 5,000 pounds per square inch for the load and span represented by that point. The points of intersection of this curve with the shaft curves are found as follows:—

Substitute 5,000 for f in (b), and inserting the value of M we have:—

$$5{,}000 = \frac{\frac{W\,L}{4}\,r}{I} \qquad (c)$$

That is,

$$5{,}000 = \frac{\frac{W\,L}{4}\,r}{\frac{\pi\,r^4}{4}} \qquad (d)$$

from which $W\,L = 5{,}000\,\pi\,r^3$. (e)

Now from equation (a), $W\,L^3 = 3{,}360{,}000\,\pi\,r^4$. (f)

Solving (e) and (f) for L we find:

$$L^2 = 672r. \qquad (g)$$

Substituting the different values of r corresponding to the different shaft diameters, we may read off on a slide rule the corresponding values of L.

The points for the curves "A," "B" and "C" were obtained in the same way by substituting 2,000, 3,000 and 4,000 respectively for f in equation (b).

It seldom happens that a fly-wheel, armature or pulley is located exactly at the middle point between two bearings, but it will be found that the use of these curves will usually give the proper diameter of shaft for a given case.

Suppose the distance between supports to be 70 inches, and the weight on the shaft 6,000 pounds. Referring to the curves, and following up the 6,000 line, it will be found to intersect the 70" line just below the curve marked 7½ and between the A and B curves, indicating that a 7½ inch shaft would be required, and the maximum fibre stress would be about 2,600 pounds per square inch.

A New Water Gauge.

From the time boilers were first invented until the present, the question of supplying suitable water gauges has occupied the attention of the manufacturers and users of steam appliances. The most familiar form and the one most generally used consists of the water glass tube type. The disadvantages of this type are well known, their breakage in the past having often resulted in serious injury to the engineer by flying

glass, as well as in much damage to the boiler. The above illustration shows a new form of gauge which is manufac-

tured by Frank M. Ashley, 138 Liberty street, New York, and which we understand is not only perfectly reliable in its indications, but safe to use and practically indestructible as well. The gauges are just twice the size of our illustration, and are made of both iron and brass. The glass used is 3-8 inch thick, and has never been known to break.

In use three or four of these gauges are screwed into the boiler; the lowest one at a point about three inches above the highest row of tubes, and the others one above the other about three inches apart. As long as the water is above the connection where the gauge is screwed into the boiler, the circular glass front of the gauge appears to be blank to the observer, but when the water drops below this connection, the water runs out of the gauge down to the point illustrated by the water line as shown in the illustration, thereby showing a distinct line across the center of the glass caused by the water standing at this level in the glass. This level is caused by the water being trapped in a recess behind the water glass, and while the water may go lower in the boiler, it can not run out of this trap, and therefore as long as the water is below the connection of this gauge, this line will be clearly distinguished across the center of the glass. When the water again rises above this gauge it is entirely filled with water and no line will be visible. Therefore if several of these gauges are in use, one above the other, and the water stands above the lowest gauge, and below the next one higher up, the lowest gauge would show blank and all of the gauges above the same would indicate the line across the center of the glass, thus showing clearly that the water line in the boiler is between the lowest gauge and the one immediately above it.

These gauges have proved themselves so particularly efficient for locomotive boilers that they are already in great demand, and their general adoption seems certain on railroads both in the United States and Europe.—*Ryerson's Monthly*.

Novel Blue-Print Apparatus.

BY H. G. GARMAN.

The necessity for having some contrivance to hold a tracing or vandyke negative firmly against the sensitized blue-print paper or cloth, and at the same time to protect from the weather both the operator and his material during the time of exposure of the print, has given rise to many inventions. The different devices range from the simplest common hand frame to the varied and more or less complex blue-printing apparatus of the automatic type, and the price varies from the insignificant cost of the small hand frame on the one extreme, to as much as $500 to $600 for the larger and more complex machines. The cost of labor for printing is nearly inversely proportional to the number of prints that the frame will hold at a single exposure, provided the tracings or negatives are fastened together, the small separate sheet system of printing being very expensive. When several prints are made at one exposure no dark room is necessary, for a large piece of paper can be quickly placed in position, exposed and washed, and then cut apart in the full light at the leisure of the operator or during the time of exposure of another frame.

It is not the purpose of the writer to describe a machine which is better than some of the best machines we now have, but rather to describe a novel device for making both large and small prints, the design and cost of which brings it within the reach of any one having such work to do.

When one is called upon to make only an occasional small print it will be found

that a small hand frame exposed directly to the sun's rays is the most economical method; but when the number of prints required increases beyond a certain limit and when the size of prints exceeds say 2x3 feet or 3x4 feet, the hand frame, if substantially made becomes very cumbersome. When prints are being made continually, as in a blue-printing establishment, the more complex electric machines are necessary, but in most places where drawings are made there is not a continual demand for prints so that the cost of one of these machines would be a waste of capital; and, too, it is not always convenient to obtain the electric current. In such case one is obliged to resort to the sun as a source of light and to some cheaper means for holding the tracings than is adopted in the special devices. The large hand frame must either be: 1. carried out of doors; 2. run out through an open window on a track; or 3. left lying on a table inside a closed window. The first method is exceedingly tiresome to the operator; the second allows a draft to enter the room and disturb papers, etc., and in winter time may endanger one's health from cold drafts; also the inside track design takes up too much space. Then, too, both of these methods during rain storms endanger the tracings and negatives. The third method is expensive in that it demands a longer time of exposure, caused by the sun's ray's having to pass through two thicknesses of glass at acute angles.

The blue-print frame to be described in this article is particularly applicable for use in the office of a consulting engineer, contractor, small division railway headquarters, etc. It has served a useful purpose in the blue-printing work done for the school of civil engineering in Purdue University. After considering all the points of economy both in the cost of apparatus and production of prints for such offices as just named, where, as already stated, the sun must generally be the source of light, a contrivance for exposing the sensitized paper to the sun should provide for the following features: 1. Minimum time of exposure; 2. protection of the tracings while exposing; 3. ease of placing the prints in frame and exposing same; 4. protection of the weather; 5. no dark room for cutting paper; 6. least possible encroachment on

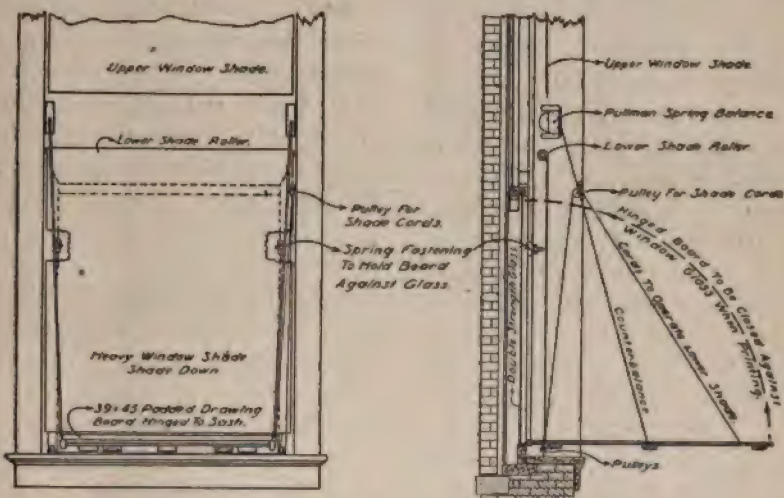


Fig. 1.

inside space in office.

The requirements are: 1. A south window; 2. a drawing board the size of the window glass; 3. a supply of heavy table padding and cotton batting; 4. two Pullman spring window counterbalances; 5. an ordinary roller window shade; 6. three hinges; 7. two spring catches; and 8. some strong cord. It is not necessary to purchase a glass of any kind, since the regular window glass is used. (See Fig. 1.)

Cut one piece of the table padding large enough to cover the board, with surplus to allow tacking to the side. Cut the remaining piece of padding into four other rectangles, each being made smaller than the preceding. Place the pad rectangles concentrically on the board, then cover uniformly with cotton batting, and over this place the largest piece of pad mentioned above, the same being tacked to the sides of the board when well stretched. This gives a pyramidal or convex form of cushion which insures a uniform pressure against all parts of the window glass, the elasticity of the glass allowing it to bulge into this form. Experience shows that the window glass should be held in place with screws and wooden strips, putty not being strong enough to permanently stand the pressure. Next place the padded board in the window, and attach the hinges to the lower side of the board, and to the bottom sash bar; attach the spring catches on the top sash or on the side sashes near the top. This holds the board firmly in place. The balancing apparatus, consisting of the two Pullman spring counterbalances, are attached one on each window casing about opposite or a few inches above the top sash, the suspenders being attached to the board on each side at such a point between the top end and the hinge as to produce equilibrium. The roller window shade is fastened to the castings about four inches above the top end of the board an inch from the sash, and both of its catches removed, making it possible to run up or down without interference. The shade is operated automatically as the board is raised and lowered, thus shutting out the light when the board is horizontal and the sensitized paper is being inserted, and runs up out of the way as the board is raised to a vertical position against the window for printing. The cord operating the curtain passes down from its two lower corners through two pulleys in the window sill where one corner passes along the bottom sash to the other pulley. Here both cords ascend together to a third pulley on the casing, where they both again descend a short distance and are attached to the board. The position of the third pulley on the casing and also the point of attachment to the board must be adjusted so that the cord distance from this pulley to the point of attachment when the board is in a horizontal position is equal to the distance the shade must travel down to shut out the light. When printing, the regular shade is drawn to where the other roller is attached, thus shutting out the light from the upper window.

When not in use the hinge pins may be drawn, the suspenders and shade cords unhooked, and the board removed, leaving the window entirely unobstructed and no floor space occupied. If but one print of a tracing is wanted, fasten the tracing on top of the sensitized paper by putting at each corner a common pin through both and into the padded board. When the board is pressed against the window glass it will hold the tracing smoothly and firmly against the paper.

When a considerable number os prints are to be made from one tracing this apparatus is exceptionally rapid. Take four pieces of chamois, 1-2 to 1 1-2 inches, at one end of which are attached two or three small rubber bands looped

together. Pin one of these pieces to each of the corners of the tracing and draw the rubber bands over the edges of the board and hook them over the heads of brass tacks placed along the edge of the board on the back side. Then to make any number of prints cut the paper to size and slip it under the tracing, raise the board against the glass, expose a sufficient interval, then drop the board, draw the paper out, and wash it. Wfth this arrangement, using fast paper and good sunlight, ome large print every 70 seconds has been made. If working during a heavy rain storm the tracings are protected from water, everything about the apparatus being inside the room.

The following statement of the costs of apparatus to take a 3x4 foot tracing includes that just described and the ordinary blue-print frame, together with the high priced appliances:

1. The best electric machine (listed)	$500 00
2. Vacuum sun frame (listed)	75 00
3. Felt cushion sun frame (listed)	80 00
4. Apparatus above described	6 87

The last named is itemized as follows:

1 Drawing board	$1.75
2 Pullman spring window counter-balances at 82½c	1 65
2 yards of table padding at 70c	1 40
1 window shade with mountings	1 20
3 pair hinges at 10c	30
3 pulleys at 5c	15
2 spring catches at 10c	20
1 roll cotton batting	12
12 feet of strong cord	10
Total	$6 87

To summarize, the device here described has the following advantages: 1. It is adapted to offices requiring a moderate amount of blue-printing, and where the more costly appliances can not be afforded for lack of either means or space; 2. notwithstanding the large size of the board the counterbalancing device enables one to insert and remove the materials easily, with no annoyance in raising or lowering a large window; 3. minimum time of exposure aud the protection of the tracings and operator from the weather; 4. no dark room or boxes required to cut the small pieces of paper, but several tracings being printed on the fnll width of the roll and then cut apart in the full light after the prints have been dried.—*The Engineering Review*, of Purdue University.

Numbering and Lettering Locomotives.

The practised eye of the experienced railroad man is quick to discern the different methods employed by the various railroad systems of the country in numbering and lettering locomotives and other equipment. Any variation from the practice employed on his own road is sure to be noticed by him, but it is safe to assume that the public in general gives it little more than a passing thought. The diagram herewith, showing some of the methods employed by railroad companies for the purpose of identification of their locomotives and for advertising their lines, is reproduced from *The Railway Age*, which says:

A recent item to the effect that the Boston and Maine has changed its method of numbering and lettering locomotives prompted an investigation of the prevailing practice on leading roads, with some astonishing results. Over 40 roads were considered, and among these there are few whose practices correspond.

The object of numbering is, of course, for identification, either in the yards, on the road or in the roundhouses, shops and terminals. The object of lettering seems upon investigation to be the outcome of an advertising spirit. Except in the terminal districts, locomotives seldom run over the tracks of foreign roads, and when they do so regularly the employes can distinguish the locomotives of any road from their appearance or numbers without reference to the initial or name.

Travelers or bystanders seldom need the name; in fact the locomotive usually is so located at terminals that incoming passengers can not see it anyway. The principal object then in displaying the name prominently is the same as that of manufacturers, that is, for advertisement. The number on the other hand is essential for identification by employes and should be prominently displayed. A study of the accompanying table will show how this is accomplished upon a number of leading roads.

The side numbers only are considered as it is customary to display numbers on the sides of the headlight and upon the number plate in front always, while in the case of double-end locomotives and switch engines the numbers are displayed on the rear of the tender. With other engines the practice in the latter respect varies considerably, but for present purposes will not be considered. The ends to be obtained are three: prominent display of number and of name, and the use of the fewest possible letters or figures as a measure of economy and to avoid confusion. The places readily available for numbering and lettering are the dome, cab and tender, although it will be seen that some roads are able to dispense with dome decorations.

Illustrations which have appeared recently of [illegible] different locomotives were used as a basis for these comparisons. Differences in size of figures were not considered, but distinctions are made between the different methods of indicating the road name, that is, whether the full name is used or the initials, or a conventional figure or nickname, such as "Big Four," "Vandalia," "Soo Line," etc. Upon this basis the [illegible] locomotives considered disclosed [illegible] different methods of lettering and numbering, while if the comparative size and form of figures and letters is considered there are hardly two alike.

NUMBER USING SAME STYLE	TENDER	CAB	DOME
10	321	[illegible] R R	321
4	PENNSYLVANIA	321	
2	L I R R	321	
3	321	SOUTHERN PACIFIC	321
5	LEHIGH VALLEY	321	321
3	B & O	3210	3210
2	321	C R I & P	
2	GREAT NORTHERN 3210	GREAT NORTHERN	3210
2	N Y C & H R 3210 FREIGHT	3210	
1	3210	FRISCO	3210
1	321	WABASH	321
1	VANDALIA LINE	321	
1	321	[illegible] 321	321
1	BIG FOUR	C C C & St L	321
1	321 CHICAGO & ALTON	321	321
1	3210 [illegible] N.Y.C.& H.R.	3210	
1	M P 3210	MISSOURI PACIFIC	3210
1	321	321 M K & T	321
1	321	COTTON BELT	321
1	PHILADELPHIA & READING	321	
1	[illegible] 321	[illegible]	321
1	321	C P R 321	
1	[illegible]	M St P & S S M	321

The arrangement which seems to be popular with the largest number is that in which the locomotive number is placed

in large figures upon the tender, the name on the cab and the locomotive number upon the dome. From the standpoint of employes this system appears very good, as the figures on the tender may be large enough to be read at long distances.

One road, the Philadelphia and Reading, uses a conventional arrangement of the name on the tender, and places the figures very large upon the cab, leaving the dome blank. This is the simplest possible arrangement, and as carried out by the Reading enables recognition of the engine number at long distances. The point may be raised that some roads where the locomotive numbers run into four figures can not use so large numerals if they are placed upon the cab; but in all cases examined considerable improvement in this respect can be made.

The New York Central, for one, has different styles for passenger and freight. Locomotives in the former service carry out the advertising idea, displaying the road initials prominently upon the tender, while the number is placed above in small characters. This arrangement is reversed upon the freight locomotives, making the number most prominent.

Roads which are handicapped by two names, a popular name and corporate title, as the "Monon" and "Chicago, Indianapolis and Louisvile," are obliged either to drop one or to go to considerable length to place both names and the requisite numbers upon the locomotive, with the result that the legibility of the number suffers.

Considering the appearance, without regard to the utilitarian requirements, the style adopted by the Pennsylvania and its allied lines is hard to surpass for simple dignity and symmetrical arrangement. The Reading, on the other hand, while fully as simple, displays the number much better. It does not make so handsome an appearance, but the figures can be read at long distances, while leaving the dome and back of the tender blank, and reduces the amount of lettering to a minimum. Obviously, when the number is on the cab, it is unnecessary to place it on the dome, although this frequently is done.

There seem to be few conventional arrangements, and it is apparent that the "trade mark" idea is going out of style as regards locomotives. It can serve no conceivable end, as locomotives are not interchanged like freight cars, and the general tendency is well toward simplification.

Something Doing in Science.

A Montana man has succeeded in raising a vineless potato.

A Cleveland man has raised a potatoless vine.

A Milwaukee man is trying to brew a foamless beer.

A California man announces that in another year he will have skinless grapes on the market.

A Philadelphia landscape gardener has discovered how to make roses grow on dandelion roots.

A St. Louis chemist is working on a substance that acts as a fertilizer for grass and poison for weeds.

A R. R. Inventory of 1833.

An old inventory of the Mohawk & Hudson railroad, dated Jan. 1, 1833, gives the following as the total rolling stock of the road at that time: Three locomotives (the John Bull, the DeWitt Clinton and the Experiment(; three carriages, accommodating 12 passengers each; nine, accommodating nine each; two accommodating six each, and three accommodating 18 each, a total capacity of 183.

Poverty never spoils a good man, but prosperity often does.

STRUCTURAL.

Standard Specifications.

—FOR—

BUILDINGS, BRIDGES, FRAMEWORK, MACHINERY, ETC.

(Continued from July number.)

29. Bolts in Erection.

If bolts are used, they will be turned and made a driving fit in reamed holes (except for girts or purlins of building, which shall be rough), and wherever possible they will be placed with a nut in the lower position. The nut will be tightly screwed up and the end of the bolt burred or riveted.

30. Testing and Test Pieces.

The manufacturer of the material will furnish and deliver free of charge to ....such test-pieces or samples as they will require, and will also make free of charge such tests of material as .... will require to properly determine the character of the material. Should .... decide to accept mill inspection for material, they shall be furnished free of charge with three copies each of all tests upon the material required for the work included in this specification.

In all cases .... shall be notified in advance when and where the material for this work is to be manufactured, so that their Inspector may be present during such manufacture.

31. Test of Eye Bars.

Full size tests of steel eye bars will be required to show not less than 10 per cent elongation in the body of the bar, and tensile strength not more than 5,000 lbs. below the minimum tensile strength required in specimen tests of the grade of steel from which they are rolled. The bars will be required to break in the body; but should a bar break in the head, but develop 10 per cent

elongation and the ultimate strength specified. it will not be cause for rejection, provided not more than one-third of the total number of bars tested break in the head, otherwise the entire lot will be rejected.

32. Painting. Unless otherwise specified, paint for steel work will be of pure American graphite mixed in boiled linseed oil, with proper dryer; no cottonseed or other cheap oil to be used. Where iron paint is specified, it will be made of iron oxide well burned, finely ground, mixed in boiled linseed oil, with proper dryer. Lead paint, where specified, will consist of pure white lead mixed in boiled linseed oil, with proper coloring pigments and dryer.

Unless marked on drawings or otherwise distinctly specified, the painting required will be as follows: All steel work is to be given one good coat of paint in shop before shipment, those parts which are in contact being given a thick coat before they are assembled or riveted up. All anchor bolts and bottoms of base plates are to be given two thick coats before shipment. After erection, all the steel work to receive a second coat thickly and evenly spread, well worked into all joints and crevices. All machined surfaces, such as pin holes, pins, rollers, etc., will be thickly coated with white lead and tallow before shipment.

The underside of all tin roofs, the lining of all gutters, and all flashings will be given two good coats of paint before they are laid, and after the roof is completed, two coats of paint thickly and evenly spread. Exterior of conductor pipes will be given two coats of paint. In all cases, the kind of paint used, either graphite, iron oxide, or lead, shall be as marked on the drawings, or set forth in the general specifications.

Before painting, all scale, dirt, or rust is to be thoroughly removed, and each coat must be thoroughly dried before the next is put on. No painting will be done in wet and freezing weather unless under cover.

If so specified, the contractor will furnish samples of paints, oils, etc., with his proposal.

33. Shipment and Marking. Where material is to be loaded on cars or boats, particular attention shall be paid to loading, that the material is not injured or bent in shipment.

It will be properly stayed and braced. When material is loaded on more than one car, particular attention to be paid to the loading of the same, that material will pass easily around curves

with proper amount of clearance and arrangement for swiveling or sliding. Small and loose parts liable to loss in shipment will be boxed or otherwise protected. All packages to be properly marked with contents of same, and all boxes and other packages and all loose pieces to have proper shipping marks upon same to conform to description marks in bills of lading, and erection marks to correspond to erection diagram marks. Before shipment, all threads and other parts liable to injury in shipment will be wrapped or otherwise protected.

34. Foreign Shipment. All material for foreign shipment is to be thoroughly packed and protected against injury in any way. Each piece is to have a separate distinguishing mark. For those pieces which are boxed or packed in bundles, the boxes or packages are to be given a separate distinguishing mark. All pieces and packages have to be invoiced, invoices to be made in triplicate, and to have export marks and exact weights of each piece marked upon same. These invoices to be forwarded to .... before shipment.

WOOD WORK.

35. Workmanship. The workmanship throughout is to be strictly first-class in every respect and done to the satisfaction and approval of .... All the carpenter work is to be properly framed and jointed. Where morticed or tenoned, the tenons are to fit closely, particular attention being paid to the squaring of the shoulders so that a proper bearing is secured. All framing is to be carefully and accurately done from templates. Where indicated on drawings, the woodwork is to be properly surfaced; where not so indicated, the timber will be considered as rough-sawed.

36. Fastenings for Wood Work. Particular attention to be paid to the proper securing and fastening of all framework with proper sized nails and spikes, or other fastenings. Where bolts are indicated on drawings, they are to be supplied with proper sized washers, and the framing throughout to be done in a thorough and workmanlike manner.

37. Material. The woodwork throughout must be of the best quality of the kind specified on the drawings or general specification. It shall be sawed true to size, out of wind, and it must be free from sap, except in sticks having a depth of 16 inches or upwards, when 1 inch of sap will be allowed on two corners. It must be free from wind-shakes, loose or decayed knots, worm holes, or other defects that will impair its strength or durability.

38. Windows. Windows will be glazed with glass of the thickness specified, thoroughly tacked and puttied in the sash. The sash will be clear straight-grained, well-seasoned white pine of the thickness specified, thoroughly framed and jointed together. The frames will be securely fastened in position and built so that the sash will slide freely and easily, and at the same time be perfectly weather-proof.

The hardware used for the windows will be strictly first-class and will be as shown on the drawings.

39. Painting. All wood framework such as windows, doors, and their frames, and all surfaced timber where painting is specified will be given a priming coat of paint before shipment from the mill, and after erection two coats, thickly and evenly spread, well worked into all joints and crevices.

ROOFING.

40. Slate. Where roofs are indicated on drawing as covered with slate, the slate will be laid in the following manner:

24-inch slates	. . . .	10	inches	to the	weather.
21 " "	. . . .	9	"	"	"
18 " "	. . . .	7½	"	"	"
15 " "	. . . .	6	"	"	"

When slates are secured to boards, the slates are to be laid on two thicknesses of tarred paper, arranged so as to break joints, and are to be secured with two galvanized nails to each slate. The lower or eave row of slates is to be double and to be thoroughly fastened. Where slates are secured directly to the steel purlins, they will be fastened with copper wires as shown on drawings. The slates are to be of good quality, acceptable to ...., of uniform thickness, properly cut, and neatly laid. Ridges or peaks of roof to be furnished with combing as shown, thoroughly fastened.

41. Tiling. Where roofs are to be covered with tile, it will be of a kind indicated on the drawing. The Contractor will furnish samples of the title with his proposal. The tile is to be well laid and fastened with two copper or galvanized iron wires to each tile, connecting same to purlins or slats. The roof is to well pointed with cement throughout and to be done in a thoroughly workman-like manner. Particular attention to be paid to the lower row of tile that it is thoroughly well fastened and the edges protected against breaking or cracking off.

42. Flashing. All skylights, ridges, valleys, and [illegible] are to be thoroughly flashed. This flashing to be neatly cut in and thoroughly fastened [illegible] in an approved manner, and where necessary to be [illegible] against leakage. This flashing will be of the material designated on drawing.

43. Corrugated Iron Roofing. This [illegible] is specified under "Steel and Iron Work." See paragraph 76.

44. Miscellaneous Roofing. All miscellaneous roofing will be as specified on the drawings [illegible] the general specification, and in every case to be of first-class material and to be put on in a thoroughly workmanlike manner.

Concrete Work and Brick and Stone Masonry.

45. Brick Work. All brick work is to be carefully and accurately laid to the exact lines and dimensions shown on the drawings. All bricks are to be laid with close "shoved" joints, and properly bonded. [illegible] number of at least every [illegible] full course of bricks to be headers, so as to thoroughly tie all courses together. Bricks to be well laid in with not more than ¼-inch joints, and to be properly wet before laying, unless otherwise specified. Where [illegible] for small arches, bricks are to be either cut to properly fit the circle or bevel brick are to be used. Particular attention [illegible] be paid to the exterior surface of all brick work that a neat and [illegible] is made, the joints to be properly pointed and struck, and all lines and angles properly carried up. In all cases the brick are to be sound, hard, well burned, and true to size. No [illegible] or soft brick will be used, and no brickbats except for filling of walls.

46. Rubble Masonry. Rubble masonry will be built up of sound, large stones, roughly hewn or [illegible], the beds being so hewn that in no case the mortar joint will exceed ¾ inch in thickness. Stone work will be well laid in with proper number of headers to thoroughly bond and tie the masonry together. In general, every fifth stone will be a header and extend back into the wall, and where practicable clear through the wall.

47. Ashlar Masonry. Ashlar masonry will consist of properly hewn stones with dressed beds and joints. Where indicated the faces of the stones will be either dressed or rock-faced. For ashlar masonry, the beds and joints will be so well hewn that the mortar joint in no case will exceed ¼ inch in thickness, and for the voussoirs of arches the joints will not exceed ¼ inch at the intrados of the arch and ½ inch at the extrados of the arch. After laying, all joints shall be neatly pointed and struck.

(Continued in September number.)

HOME STUDY.

Machine Design.

Tooth Gearing

It will be recognized from the sketches so far in this article that the teeth have an outline that is bounded by curves instead of straight lines.

These curves are the result of the teeth of one wheel working with those of the other. If a point on one wheel were to trace a line on the surface of the rim of the other it would be found to be a curve, and to designate the kind of curve ... have been given.

the curves instead of going through the tedious process of laying out a cycloidal or involute curve.

Prof. A. Edward Rhodes, in the article following, will take up this part of the subject.

Wheel Gearing.

By Prof. A. Edward Rhodes.

The best shop method I know for drawing the teeth of wheel gearing rapidly and approximately correct is shown in Fig. 1, and is used, I believe in the

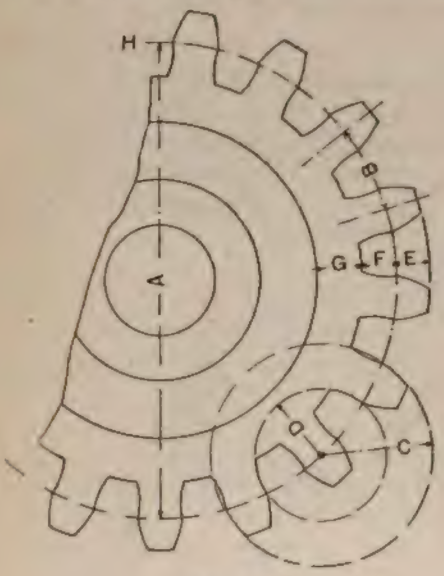


Fig. 1.

majority of drafting rooms, especially for wheels of from ¾" to 2" pitch. Making the drawing may be explained as follows:

H is the pitch circle on which the width of the teeth and the spaces between them are marked.

Then with a radius C equal to a pitch and a fourth from the middle of each tooth on the pitch circle, describe the sides of the tops of the the teeth.

The sides of the teeth within the pitch circle are drawn with a radius D equal to three-fourths of the pitch, and the middle of each tooth on the pitch circle for centers.

The following simple formula may be used when drawing the teeth of wheel gearing when the pitch is known:

A = B × number of teeth ÷ 3.1416.

B = Pitch = distance between centers of teeth on pitch circle.

C = B × 1.25.

D = B × .75.

E = B × .32.

F = B × .38.

G = B × .50.

H = Pitch circle.

For gears of pitches less than ¾" the the involute or single curve system is

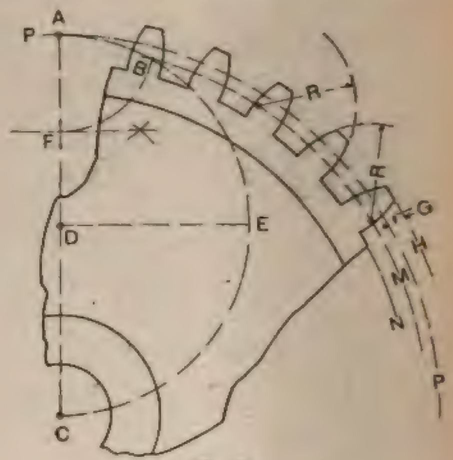


Fig. 2.

often used. The drawing, Fig. 2, may then be made as follows:

Let A C be the radius of the pitch circle P of the gear.

Bisect A C at D, and from D as a center, and with a radius A D or D C, draw the semicircle A E C.

Bisect A D at F, and from A as a center, and with a radius A F, draw an arc cutting semi-circumference A E C in B.

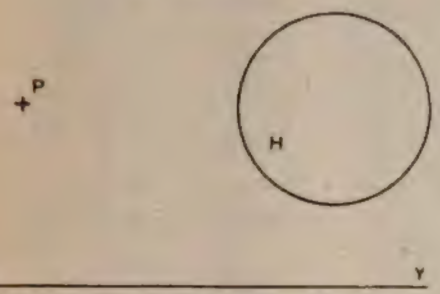
From the center C, with a radius equal to C B, draw a circle M, which will be the base circle on which all the centers of the tooth arcs are located, and the radius R of each tooth arc is equal to A-B, which, as will be seen by the construction, is equal to one-fourth of the radius A C of the pitch circle.

To find the addendum circle H, multiply the circular pitch (distance B, Fig. 1), by .3183. The result will be the distance G from the pitch circle.

The distance from the pitch circle to the whole depth circle N is equal to G plus $\frac{1}{10}$ of the thickness of the tooth at the pitch circle P.

All gear wheels should have their teeth strengthened by as large a fillet at the root of the teeth as clearance will permit, as this is the point where teeth usually break off.

Problem.



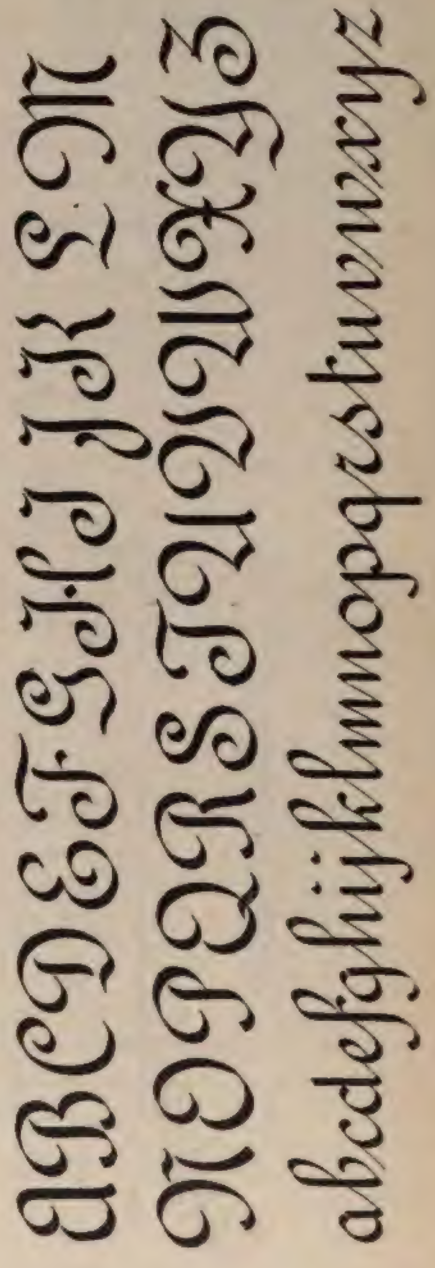
To draw an arc through point P and tangent to circle H and the right line XY. Send in solutions.

It isn't hard for a clerk to find good points in a boss that finds good ones in him.

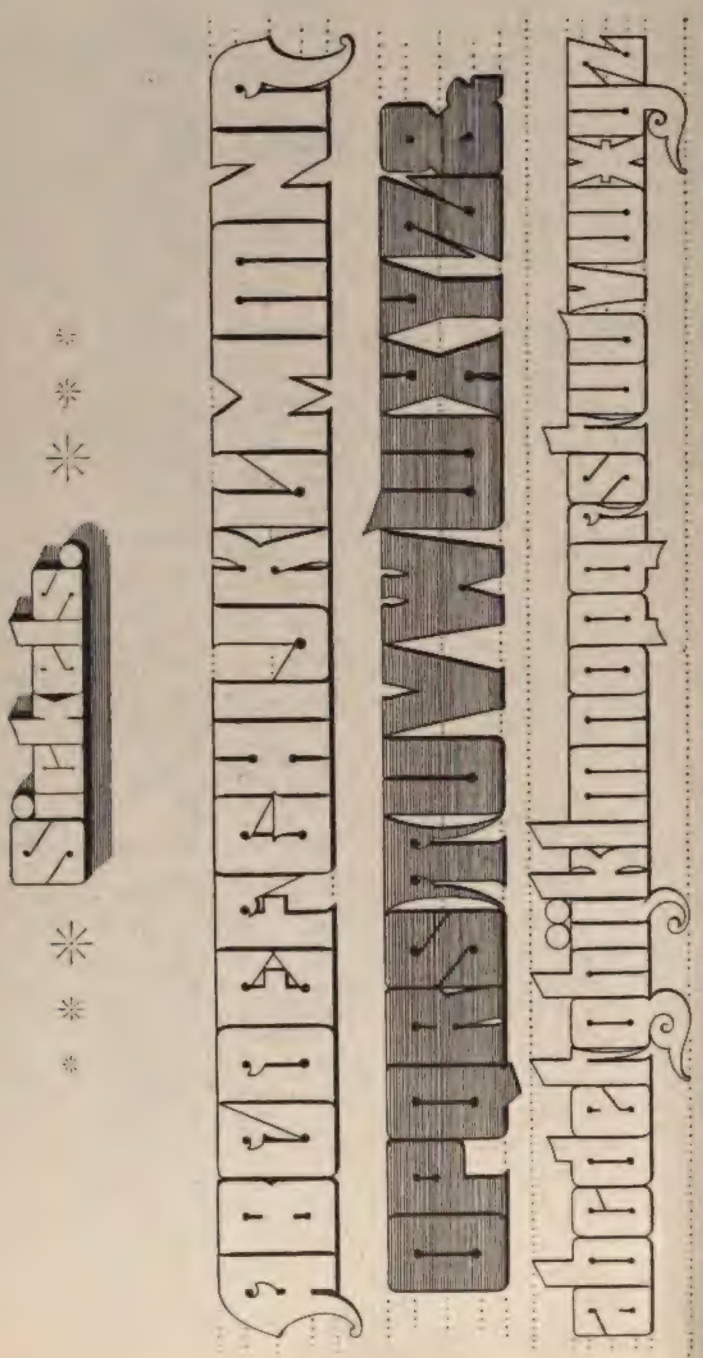
You can trust any number of people with your money, but mighty few with your reputation.

When a man whines that he is being held down, the truth is, as a general thing, his boss can't hold him up.

Fancy Lettering.



Fancy Block Lettering.



No alphabet is susceptible of so many variations as is the Sickels. This alphabet by Mr. Flickinger shows the style most commonly used by engrossing artists. It can be line shaded, or a brush may be used with pleasing effect. *Penman's Art Journal.*

CURRENT TOPICS.

FELLERS th't blunder c'n be divided int' two classes,—one th't says "I thought," an' another th't says "I didn't think."—*Josh Wise.*

THE *dollar* is the final term in almost every equation which rises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically.

Ordering and Marking Blue-Prints.

Systems in regard to ordering, marking, delivering and filing blue-prints vary in different manufacturing plants. To a great extent, however, the same general conditions exist.

The following gives the routine of a blue-print order card at present being used by the Browning Engineering Co. First let us consider what a blue-print really is. Broadly we may say first that it is an order to the shop from the billing department. And as these orders at times are needed immediately, as in the case of repair work, it stands to reason that the sooner it can be consistently delivered the better for all concerned. At the same time correct records should be kept for future reference. So secondly we can call our blue-print a record.

Fig. 1 shows the Blue-Print Order Card before being filled in. These forms are padded and used as follows: The billing clerk having made out the bill of material, say for a repair job, then fills out this blank (see Fig. 2), being a special marked up print. The new drawing number is given, also the tracing number, to notify the blue-print boy which one to use. Then the shop

THE BROWNING ENGINEERING CO.
CLEVELAND, O.

Sheet No.		S. O. No.
Tracing No.		No. Prints this S.O.
Date put in Shop Record		
Date put in Drafting Record.		
Date for Struct'l Shop, one print.		
Date mounted for Shop, one print.		
" " " " "		
Date for Pattern Shop, one print.		
Contract	Remarks	

order number and the number of prints wanted, in this case four. Note that there are four check marks in the small squares. This notifies where prints are to go, and the space to the right of these is for the date to be stamped in as they are delivered, see Fig. 3, which is the filled in notice that the machine and pattern shop both received prints before the record prints were delivered. This is the advantage of this system: it allows one to deliver prints and keep a correct record at a moment's notice and without having to complete the rest of the orders until ready to do so.

When the rush is all over, and all

THE BROWNING ENGINEERING CO.
CLEVELAND, O.

Sheet No. 3315 S. O. No. 2861

Tracing No. 2519 No. Prints this S.O. 4

Date put in Shop Record	✓	
Date put in Drafting Record.	✓	
Date for Struct'l Shop, one print.		
Date mounted for Shop, one print.	✓	
" " " " "		
Date for Pattern Shop, one print.	✓	

Contract Repair Remarks Mark print as per S.O. 821

Fig. 2.

THE BROWNING ENGINEERING CO.
CLEVELAND, O.

Sheet No. 3315 S. O. No. 2861

Tracing No. 2519 No. Prints this S.O. 4

Date put in Shop Record	✓	JUL 1 1905
Date put in Drafting Record.	✓	JUL 1 1905
Date for Struct'l Shop, one print.		
Date mounted for Shop, one print.	✓	JUN 26 1905
" " " " "		
Date for Pattern Shop, one print.	✓	JUN 26 1905

Contract Repair Remarks Mark print as per S.O. 821

Fig. 3.

prints are made and put in record books, the card can be filed in card index case or copied in a contract record or drawing record book, in the previous time no handling of books or records has been done. The order has been fastened with a clip to one or more blue-prints. The number of prints it is fastened to, plus the number of dates stamped should equal four in this example if the order is filled. When all dates are on, of course, the card is returned to the drafting room

Should there happen to be two or more orders requiring the same blue prints, there will be no chance of error, as each set of prints has its own order card fastened to it, and the shop order number then notifies which job they are for. Note that in this system there is a card for every sheet number. There may be fifteen or twenty sheets on the same shop order, but the sheet number is the guide.

IN LOOKING through a city directory it was noted that many draftsmen lived on a certain street. That is a good indication that it is a nice neighborhood. If it were possible to secure the names and locations of good boarding and rooming houses in all the cities where draftsmen are likely to be employed, and have this information in a convenient place, it would be worth something to men of our profession. We would be glad to circulate this information if we had it.

Organization.

Referring to the article in THE DRAFTSMAN for June last on organization, I wish to say that I think the writer has struck the keynote of our needs.

Organization and co-operation is the spirit of the age, and the engineers must organize sooner or later if they are to keep abreast of the age. Why not do it now? Nearly every other line of workmen have their organization for mutual aid and protection. "In union there is strength.

Employers are not going to pay any more for work than they have to. The engineering profession contributes as much to the world as does any of the other professions, and why should they not be as well paid? That they are not is a well-known fact, and it is because they do not demand it. We are neither protected by law as a profession nor by organization as a trade.

An organization would afford both a protection and a standard of qualification for first-class workmen. It would improve both the quality of the work and the wages. R. L. S.

Better Designs Needed.

In a recent number of a home paper we note that there was a complaint that persons were injured and often killed as a result of poor fenders on the street cars. The cars of Cleveland are equipped with fenders which are claimed to be very effective. In fact, the salesmen will throw themselves in front of a moving car to prove this fact. In a recent interview the president of the street railway company stated that no fender had been found that was effective, that would pick up a child, for instance, when it had fallen between the rails. A notice appeared to the effect that the cars of Pittsburg were not equipped with fenders, but they were not looking towards Cleveland. If that is the case, there is a field for the inventive genius of the designer to supply something that is effective.

To meet the unemployed difficulty in Manchester, Eng., a new industry—collecting scrap tin from rubbish heaps—has been started.

Regulations for Stand-Pipes.

The following regulations for stand-pipe fire-line work on buildings in New York have been adopted.

Standpipes will be required in all buildings exceeding 100 feet in height, erected prior to Dec. 25, 1899, and in all buildings exceeding 85 feet in height erected since that date. Such buildings as come within above classification, and which do not exceed 150 feet in height, in which standpipes (fire-lines) now installed are less than three inches in diameter, must be provided with lines four inches in diameter, and in such buildings as exceed 150 feet in height the fire-line must be six inches in diameter unless the lines already installed are considered satisfactory and approved by the Fire Department. These standpipes must be of wrought iron or steel of sufficient strength to withstand the necessary pressure—in no case less than 300 pounds to the square inch — to force adequate streams of water to any of the floors of the building, or to the roof, and must extend from cellar to roof and be connected with outside two-way, three-inch, standard fire-department connections, with clapper valves and proper caps, placed on street front of buildings, above curb level, in a position accessible for use of the Fire Department and arranged so that the clapper-valves hang properly.

These standpipes must be provided with proper valves (gate-valves preferred) and two and a half-inch outlets of the regular fire-department pattern and thread on each floor level, with sufficient standard two and a half-inch hose and nozzles arranged thereto to cover properly the entire floor area, arranged on proper and approved racks or reels, with improved open and controlling nozzles. Proper check-valves shall be placed in top and bottom of such lines as are required to use tank or pump supply, or both. The hose outlets and hose must be located within stairway inclosures, except where it is impracticable to do so for reasons satisfactory to the Department. Where more than one standpipe is installed, cross-connections, preferably in the basement, of the same size as the main risers, must be provided. In all buildings over 150 feet in height and in such buildings as come within these regulations as to height and are occupied for living purposes, such as hotels, hospitals, asylums, etc., also in theaters, the stand-pipe line must have approved tank or pump supply, or both.—*Southern Architect.*

Wind Bracing.

Wind bracing is a system of steel connections, which in the body of a tall building serve a purpose similar to that of the interlacing muscles and tendons which bind together the bones of the human skeleton and enable it to act altogether, as a unit, in resisting forces tending to upset or crush it. In a scientifically constructed building the force of the wind pushing against the upper portion arouses a resistance which is transmitted downward from story to story, and distributed on all sides from member to member of the steel skeleton, until it is felt at the foundations, and thus the strength and weight of the lower portion of the building, lying in the shelter of the surrounding edifices, out of reach of the wind above, are brought into play for the common defense, very much as the effects of a push against a man's shoulders are distributed throughout his muscular system down to his feet, and thus resisted by his whole body.

It's easier to look wise than to talk wisdom.

Farmer Boys the Best Bridge Workers.

In the building of the modern railway bridges in the central west the builder finds a great deal of his workers' material in the sturdy, intelligent young men from the farms and small towns. The skill is looked for in the directing heads acting under the tuition of training and experience in shop and bridge work. In the experience of a Chicago firm the average young farmer of twenty-three years old becomes more or less a skilled executor of bridge work after five months' training. The foreman in a special work has his squad or squads of men. They may be found in many places, already having had experience now and then at a little bridge work, and for many of these a taste of the work is enough to establish the adventuresomeness in them; they are bridgeworkers thereafter on all occasions.

In some of the great heights to which men have to go and in others of the dangerous places, where the nerves of men are tried, veterans of the work are in demand, some of these finding more or less steady work in the superstructures. In the spring some of the big concerns send out men in groups, a foreman with one or two men, and on many occasions two or three young fellows, taking to the work, drift back to town with them. bridge builders.

Bridge building in many of the emergencies brought about by natural conditions, becomes almost too large for even organized capital. Bridges over the Mississippi and Missouri rivers, for instance, are nearly always the work of an independent organization; the railroads have their bridge departments, but most of them halt before such a stream as the Mississippi. Four or five big railroad companies have been required for the building of the bridge at Thebes, below St. Louis, while in several places on the map, where bridges are considered eminently desirable and perhaps promising profits, the money has not been possible.

Wisdom from Old Gordon Graham.

Worrying is one thing in which, if you guess right, you don't get any satisfaction out of your smartness.

When you're right you can afford to keep your temper, and when you're wrong you can't afford to lose it.

Consider carefully before you say a hard word to a man, but never let an opportunity to say a good one go by.

Whenever a man offers to let you in on the ground floor it's a pretty safe rule to take the elevator for the roof garden.

There isn't any such thing as being your own boss in this world unless you're a tramp, and then there's the constable.

There's nothing comes without calling in this world, and after you've called you've generally got to go and fetch it yourself.

When a man's got a straight backbone and a clear eye his creditors don't have to lie awake nights worrying over his liabilities.

You can trust a woman's taste in everything except men, and it's mighty lucky she slips up there, or we'd pretty nigh all be bachelors.

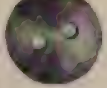
When a boy's had a good mother he's got a good conscience, and when he's got a good conscience he don't need to have right and wrong labeled for him.

Centre Pull Thumb Tacks.

Every draftsman realizes the inconvenience of thick edges on the heads of thumb tacks, also the difficulty in removing tacks having heads with a thin edge without damaging the edge.

The illustrations show a departure from the ancient method of removing thumb tacks, by means of which one with a knife-edged head may be easily removed, and without in any way injuring the edge or the finger nails.

Each head is provided with two small holes into which a key or puller is inserted, and the tack is removed by a slight twist and pull. As the tack is removed by a straight pull instead of prying, there is also no tendency to bend the pin, and this gives the tack longer life. Besides this the head and pin are made of one solid piece. The edge of the head of this tack lies very close to the paper, and permits the drafting tools to ride over the head uninjured instead of striking against it as is so often the case.



A trial dozen may be secured for 25c. from the Universal Drafting Machine Co., 220-224 Seneca St., Cleveland, O.

Civil Service Examination.

The United States Civil Service Commission announces an examination on Aug. 16-17, 1905, to secure eligibles to fill a vacancy in the positions of rodman at the Isthmus of Panama, assistant steam engineer at the U. S. Penitentiary at Atlanta, Ga., and a typewriter and translator at San Juan, P. R.

Pumice Stone.

Pumice stone is a porous feldspathic scoria from volcanoes. The pores are linear and so fine as often to be barely visible except by means of a magnifying glass. Its specific gravity is 2.2 to 2.4—water being the unit—but by reason of its spongy texture pieces are often buoyant enough to float on water. It consists chiefly of silica, with sometimes 17 per cent of lumina, 6 per cent of soda and [illegible] per cent of potash. It is of grayish shades of color, passing into yellow and brown. The chief source from which it is obtained for commercial purposes is Campo Bianco, one of the Lipari islands, where it forms a hill nearly 1,000 feet high. In the arts pumice is largely employed, mostly in a pulverized state, as a polishing material for ivory, wood, glass, marbles, etc. It is also used in lump for grinding and smoothing metallic surfaces, leather, etc., and in the preparation of parchments, etc. Quantities of the pulverized pumice are used in making fancy soaps.

Passing of the Mackintosh.

Two factories at Cannington and Silvertown established to meet the demand for mackintosh material have recently been closed, owing to lack of orders.

The manufacture of the material out of which the waterproof mackintosh is fashioned has in the short space of three years been completely upset by the advance of rainproof cloth.

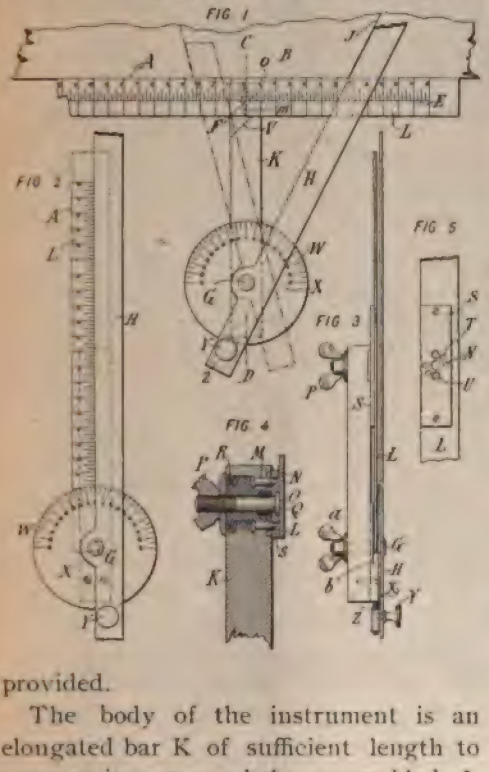
New Inventions.

The following inventions have been specially reported for THE DRAFTSMAN by C. LeRoy Parker, solicitor of patents, 707 G street, Washington, D. C.

BEVEL AND SQUARE.

No. 790,496, Jacob Graff, May 23, 1905. This invention aims to provide an improved instrument for laying off angles or in any roofing, carpentering or similar work. The instrument has a scale arranged at a standard distance in advance

of the pivotal point of the level blade. Supposing this standard distance to represent twelve inches, there is a scale marked in twelfths and subdivisions thereof, which represent inches and fractions of an inch, and when the edge of the bevel blade is brought into coincidence with a division on the scale it at once extends over the face of the work at an angle whose components are respectively the distance on the scale and the standard distance. For example if the bevel blade crosses the scale at a point marked "3" then the angle laid out is three in twelve, or three inches in a foot. This is the most common way of indicating angles and therefore the tool works without calculation or previous laying out on a separate drawing board. An angular scale may also be



provided.

The body of the instrument is an elongated bar K of sufficient length to carry at its outer end the square blade L a suitable distance from the pivotal point G of the bevel blade. The square blade need be only sufficiently large to carry the scale E and to be stiff and strong, and is preferably pivoted at the end of the body K, so that when the tool is not in use it may be swung into substantial coincidence with the body. The square blade is entirely above the body K, so that there is no obstruction to the free swinging of the bevel blade H from end to end of the scale.

Means are provided for clamping the square blade in its operative position, and preferably also a lock or latch is provided for determining this position with accuracy and quickness. For this purpose a pair of spring pins M are carried in the end of the body K, and a pair of apertures or depressions N are provided on the outer side of the blade L. As the blade is swung about its pivot to its right angle position, the points of the pins M enter the depressions N. Only the points of the pins enter the depressions, the bodies of the pins being too large. Thus the blade is held in exact position. In order to clamp it firmly in this position, the pivot pin O carries a thumb nut P on its lower end. In order to lift the blade L free from the pins M, a spring Q is provided, which presses the blade outward as soon as the thumb-nut P is unscrewed. Screws R serve to hold the pins and their springs in place and to regulate the stiffness of the spring pressure. In order that the clamping and locking means described shall not interfere with the freedom of movement of the bevel blade H over the face of the square blade L, the latter is provided near its pivotal point with an extra plate S on its under side in which are formed the depressions N and the socket for the pivot pin O.

PROTRACTOR.

No. 789,044—Clarence E. Mentzer, May 2, 1905. This invention consists of a protractor for attachment to, and use

in connection with an ordinary T-square or parallel ruler on a drawing board or table of common construction whereby a very convenient instrument of such a character is provided and one which is adapted for use with any kind of a ruler and the blades whereof may be interchanged and are adapted for various adjustments.

Fig. 1.

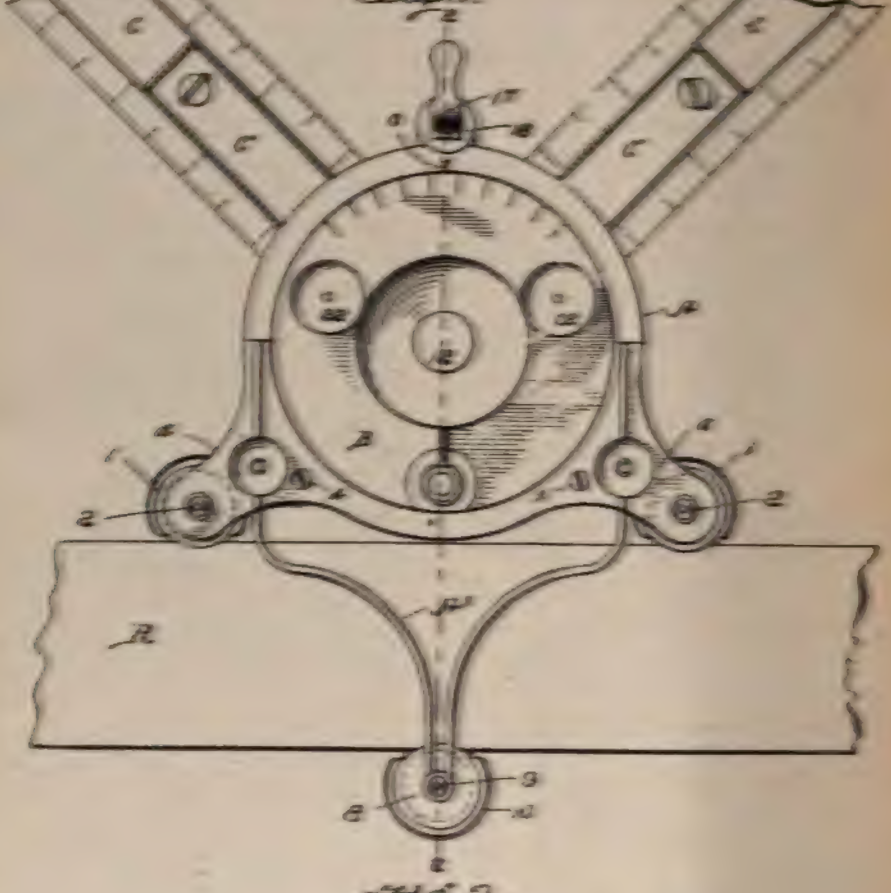
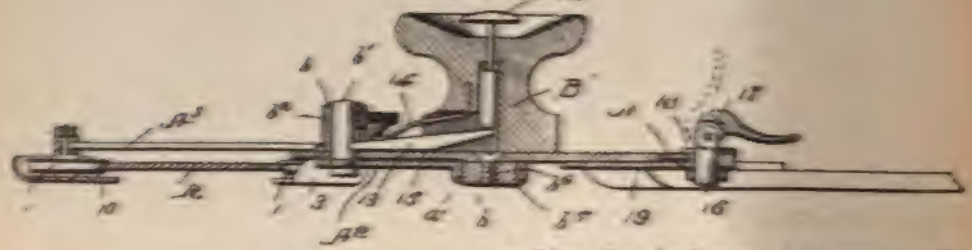


Fig. 2.



This protractor is so arranged that it can be quickly and easily attached to a ruler or T-square of any width without disturbing the connection between the ruler and the drawing-table and which enables the draftsman to secure every possible angle quickly and conveniently. The blades being removable, different kinds of blades may be used interchangeably, adapted for different kinds of work.

BEVEL-SQUARE.

No. 789,578—Morton G. Swan, May 9, 1905. The bevel-square contemplated in this invention comprises essentially a stock 1, which is composed of wood of the requisite thickness to provide for the formation therein of a slot 2, which extends longitudinally of the stock the greater portion of the length thereof, which slot may be described as being disposed edgewise of the stock or in a plane parallel with the opposite upper and lower faces of the stock.

Lying within the slot 2 is a combined brace and connecting blade 3, which is pivotally mounted at 4 within the slot, the pivot 4 occurring intermediate the ends of the part 3 and closer to one end than to the other, as shown, so that portions of the blade or connecting-blade may extend on opposite sides of the stock 1 when said brace is swung outward at an angle. At or near the outer extremity of the longer arm of brace 3 the latter is provided with a thumb-screw 5, which is received in and adapted to work lengthwise of a curved slot 6 in the elbow or short curved arm 7 of the L-shaped plate 8. The plate 8 is provided at a point about midway of its longer arm with a hole 9 to receive the shank of a thumb-screw 10, which is inserted through the end portion of the stock 1, said plate passing through the slot 2, above described.

Fig 1

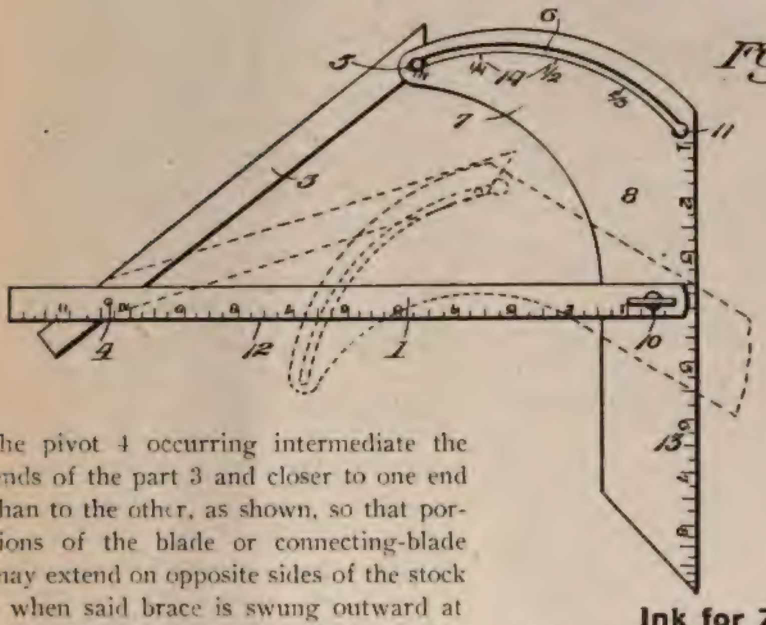
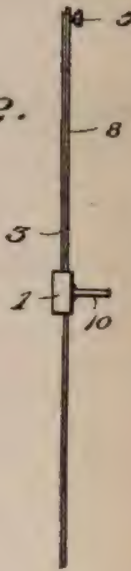


Fig 2.



Paste for Paper to Iron.

For pasting paper to iron or steel, mix Dexterine with water and boil it down until it assumes about the consistency of very thin glue; it will not hold on oily substances.

The ink plant of Columbia is a curiosity. The juice of it can be used as ink without any preparation. At first the writing is red, but after a few hours it changes to black.

Ink for Zinc.

An ink which can be used with a drawing pen on zinc and which is acid proof, is made of one drachm verdigris, one drachm sal-ammonia powder and one-half drachm lamp-black, mixed with ten drachms of water.

There's nothing breeds work in an office like a busy boss.

Odd Facts about Color.

ONE OF THEM IS THAT THERE IS NO FOOD THAT IS BLUE.

Did you ever notice that there is no blue food? We eat things green, red, yellow and violet; flesh, fish or plants in all the colors of the rainbow, except blue.

Many deadly poisons are blue in color, such as bluestone or the deadly nightshade flower. The color stands in our slang for everything miserable and depressing.

But this is only one of a thousand queer facts about colors.

Heat a bar of iron and the particles of the metal are set in motion, shaking violently one against another.

Presently the surrounding ether is set in motion in large, slow waves through the air, like the waves of the sea, until they break upon our skin and give us the sensation of heat. As the iron gets hotter other waves are set in motion in immense numbers, traveling at more than lightning speed, and these break upon the eye, giving us the sensation of red light.

The red-hot iron, getting still more heated, throws out other sets of waves, still smaller and more rapid—orange, yellow, green, blue, indigo, violet, all the colors of the rainbow. The eye cannot tell one from another; the whole bundle of rays mixed up gives us an impression of white. That is the glow from white hot iron, and such is the light from the still greater brightness of the sun. Sunlight is a bundle of rays of light—red, orange, yellow, green, blue, indigo and violet all mixed together. The mixture of all colors is white light. The absence of all color is utter darkness.—New York Journal.

Shorter Hours.

A uniform eight-hour work day for architects and draftsmen has been recommended to Cleveland architects by the Cleveland chapter of the American Institute of Architects.

There has been no uniformity in the observance of national holidays and the Saturday half holiday during July and August and September by the architects of the city, and as a consequence there has been considerable confusion in the different offices. The matter was thoroughly gone over at the regular meeting of the chapter held last week and recommendations were made for the uniform observance of the hours of labor and of holidays. The architects will close their offices on New Year's day, Decoration day, Christmas, July 4, Thanksgiving and on the afternoon of Washington's birthday and Labor day.

It was decided to recommend that eight hours be constituted a day's work for architects and draftsmen. It was also decided to recommend that the employes of the different architects be given a Saturday half holiday during the months of July, August and September.

One improvement might be suggested to the Indiana genius who proposes to utilize cats for the generation of an electric current for lighting. He proposes to round up the cats and drive them through a chute so they will pass under rotating brushes which will abstract the desired current. If he can but train mice to race through the chute ahead of them the cats might be drawn through by induction.

To write on glass use 1 to 2 parts of silicate of soda mixed with 11 parts of liquid ink. Use a steel pen and wipe it after using.

Waterproofing Blue-Prints.

The waterproofing medium is refined paraffin, and is applied as follows: A number of pieces of absorbent cloth, about a foot square, are dipped in melted

paraffin until thoroughly saturated; when drawn and cooled, they are ready for use. One of the saturated cloths is spread on a smooth surface, the dry print is placed upon it, and a second wax cloth on top. The whole is then ironed with a moderately hot flat-iron. The paper immediately absorbs the paraffin and becomes translucent and waterproof.

The lines of the prints are intensified by the process, and there is no shrinking or distortion. As the wax is withdrawn from the cloths, more can be added by melting small pieces directly under the hot iron.

By immersing the print in a bath of melted paraffin, the process is hastened, but the ironing is necessary to remove the surplus wax from the surface, unless the paper is to be directly exposed to the weather and not handled.—*The Inventive Age.*

More Work for Draftsmen.

It is reported that The Wellman-Seaver-Morgan Co., Cleveland, O., formerly The Wellman-Seaver Engineering Co., has secured a contract to erect steel plants in British India to cost $4,000,000.

The Modern Plow.

Thomas Jefferson invented the modern plow. There were plows, of course, thousands of years before the time of the Sage of Monticello, but he first laid down the mathematical principles that underlie the construction of the plow and so enabled any blacksmith to make one. A plow consists of two wedges, a cutting and a lifting wedge, and Jefferson discovered and enunciated the proportions of each and the relations each bore to the other. Before his day no two smiths made plows alike. Now they are all made in accordance with a mathematical formula.

Wireless for Train Dispatching

Train dispatchers may soon be relieved in part of the responsibility now attaching to their post when once a train has passed their station without receiving forgotten orders, if the experiments about to be undertaken at Purdue University result in determining a practical method of adapting wireless telegraphy instruments so they may be successfully used on moving trains. The intention of the professors is to conduct a series of tests to the end that a receiver may be placed in the cab in reach of the engineer from which he may take his running orders from the dispatcher without stopping his train. Prof. Kelsey, of Purdue, has already conducted a series of experiments which lead him to believe the difficulties hitherto encountered in working with trains have been overcome, and the university at Lafayette, Ind., is exceptionally well situated to put to a practical test his theories, since the electrical engineering building of the institution commands a view of long stretches of four railroads, and instruments will be placed on various trains for testing purposes.

Notice the number of positions open?

Good Reading.

After sorting out the back copies of THE DRAFTSMAN for bound volumes there remain a few odd numbers, about an equal quantity of the following issues. The more important articles are here given and there are many illustrations to each one.

January, 1902—

Engine Proportions.

Boiler Notes. Dimensions of Keys. Notes on Cranes.

Design of Scissor Trusses. Gas Pipe for Building.

Concerning Beams, I. Standard Connections. Angles. Lettering.

February, 1902—

Engine Governors. Cost of Horse-power. Boiler Bracing.

Concerning Beams II. Numbering Drawings. Drawing Boards. Rivet Heads.

March, 1902—

Arms of the Pulley. Transmission of Power by Ropes.

Rules for making Shop Drawings.
Gauge of Track on Curves.

Indexing Periodicals, etc.

Blue Printing by Electric Light.

While there are a set of three in stock, they will be sent, postpaid, for 10 cents.

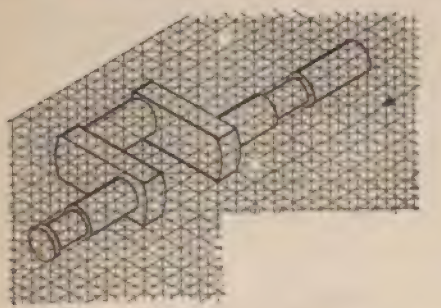
This is fine material for your note book. Order at once. Address,

THE DRAFTSMAN,
Cleveland, Ohio.

BOOK REVIEWS.

PRACTICAL PERSPECTIVE, by Frank Richards, 60 p., 5¼x8, flexible cloth backs, 62 illustrations, price 50c. The Derry-Collard Co., publishers, 256 Broadway, N. Y.

This book takes up the principles of isometric perspective and the use of isometric paper. The author was led to



write the book from the fact that few persons are able to sketch anything in perspective or pictorial manner.

A plain mechanical drawing is not readily descriptive to the untrained eye, and mechanics, especially draftsmen, should understand the principles which will enable them to make intelligible sketches of machinery. The difficulty with perspective is in drawing the ellipses which represent the circular parts, but this is clearly defined and illustrated.

The paper used in sketching is ruled as shown in the illustration, and can be secured in pads 6x9, 9x12 and 12x18.

TABLES FOR ROOF FRAMING, with logarithms of 32ds from 0 to 60 feet, also signs, tangents, etc., for draftsmen, by G. D. Inskip. Flexible, leather, tape bound, 5¼x7 inches, 208 p., price $2.50. Myron C. Clark publisher, 13 Park Row, N. Y. The object of this work is to lessen the labor and to insure accuracy in all computations of an oblique character.

All tables are in strong, clear type, so arranged that on opening the book one can readily find the desired figures. The tables of squares and logarithms occupy the greater portion of the book, then the logarithms of pitches per foot run from 1 to 18 inches advancing by 32ds, then the trigonometric functions, also logarithmic functions, then the logarithms of numbers (1 to 1,000), then the logarithms of 64ths from 0 to 1 inch, and their decimal equivalents. Following this is the explanation of tables, the locating of purtins, the ratio of altitude to base in oblique triangles (with examples), how to compute any square at will, to find the radius of an arc and diagrams of hips and valleys, &c, &c. This work is especially designed for engineers, architects and draftsmen.

No. 1 of The Engineering Review, published by the engineering societies of Purdue University, Lafayette, Ind., has been received. This is published annually, and contains many good articles of original matter.

THE DRAFTSMAN

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Tool Drafting.

By S. E. BOYNTON

LESSON 1.

THE object of this series of lessons is not only for the instruction of beginners in tool drafting, but also for those who are already tool men, and who wish to become more proficient in up-to-date methods of tool design.

To specialize in any one branch of drafting, you should follow your chosen work systematically, and adopt a system of working which will lighten the task and enable you to work quickly.

These lessons will explain a practical system which is now successfully used. The mechanic cannot help but profit by it.

The first lesson may seem somewhat elementary (as all first lessons are), but we must begin at the beginning or not at all.

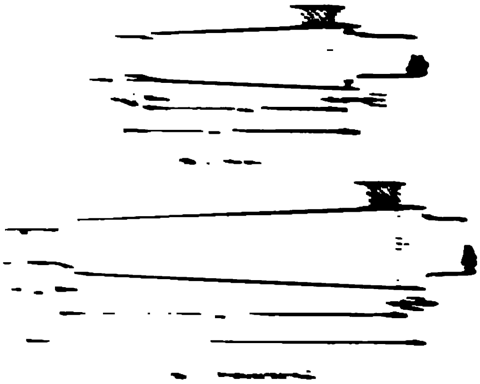
In Lesson No. 1 we will take up the study of arbors, sometimes called mandrels.

There are several kinds of arbors,—lathe arbors, nut arbors, milling machine arbors and gear arbors. These different arbors are practically for the same purpose. With the exception of the milling machine arbors, they are all for holding work to be machined on centers.

A lathe arbor is shown in Fig. 1. Those acquainted with shop tools will recognize it as a very necessary tool. It is used on the lathe or on any machine which has a pair of centers.

The lathe arbor is the simplest form of arbor. It is made of tool steel, hardened and ground on a taper of [illegible] of an inch for each inch of length, and is [illegible] undersize at the small end. The centers at either end should be lapped, and the center drill should run in a little to make a perfect fit for oil, as shown in Fig. 2. The dimensions shown are for an arbor of one inch diameter. The lengths may be obtained from the regular catalogues, or made to suit conditions.

It will also be noticed the ends are



At the outside end of the arbor in Fig. 3 will be seen a large center; this is for steadying the arbor when taking heavy cuts. A center is provided on the milling machine for this purpose.

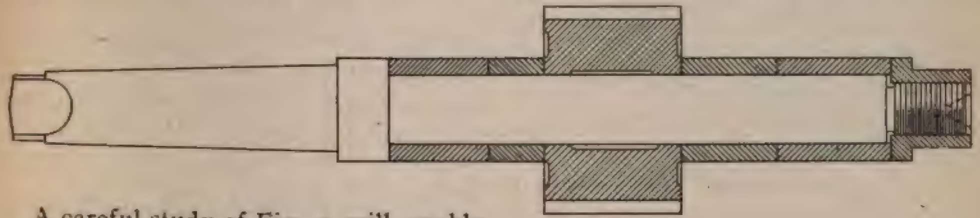


Fig. 3.

A careful study of Fig. 3 will enable you to see some of the minor details. The form of nut which has only two flats; the tongue at the shank end which fits a slot in the spindle. Notice also the slight taper at the extreme end of shank. This taper is the same as that on a wedge used to force out the arbor from the spindle.

Not all milling machine arbors have a tongue on them,—some depend entirely on the fit of the taper of the shank to hold them from twisting around in the spindle.

Another style of arbor is that used for side and end mills. These arbors are provided with a taper shank as in Fig. 3,

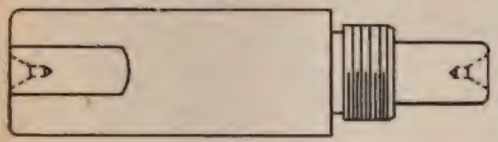


Fig. 4.

but the arbor part extends only a short way out from the milling machine spindle, or just far enough for the cutter and a screw, as shown in Fig. 5. A milling cutter is shown on the arbor.

There are also arbors provided with screw threads which fit the thread in the cutter, and in drawing these arbors care should be used with regard to the thread. The thread should be made so as to tighten the cutter,—that is, do not draw a right hand thread when it should be left hand.

Those who wish to follow this course properly, should draw up the different arbors as explained, as that is the best way to memorize them.

The following arbors will be good practice for drawing:

(*a*) A half-inch diameter lathe arbor.

(*b*) A three-inch arbor with cast iron expansion bushing.

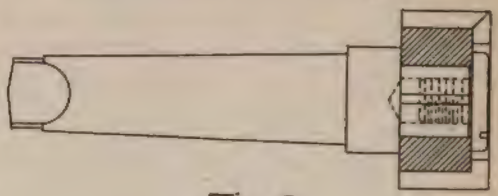


Fig. 5.

(*c*) A milling machine arbor for cutters with a one-inch diameter hole, eight inches long on the arbor proper, with a No. 10 Brown & Sharpe taper shank. See taper.

(Those who desire to have their drawings criticised may send them, with postage enclosed, to the residence of S. E. Boynton, 310 Hancock street, Brooklyn, N. Y.)

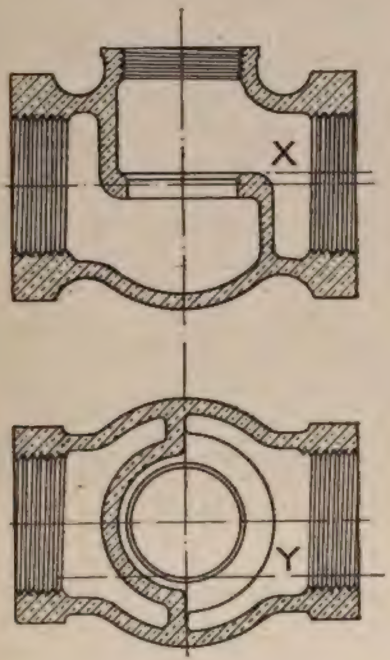
Position of Valves on Pipe.

How often we notice a valve placed in a pipe line with the stem pointing upward. Sometimes these are placed this way in piping twenty feet from the ground, and when a person reaches from

a ladder they are very awkward to handle.

Why not have the handles pointing outward?

In the diagram we have in the top view a section of a globe valve with disc and stem removed, but if in position would point upward. The dot and dash line indicate the center line of the pipe, and it will be seen that a liquid coming coming from the side *X* would have to rise higher than the center line before it can pass the valve when the disc is up.



In the bottom view of the illustration the highest point is shown at which the liquid would have to be to run through the valve if the stem was turned to the side.

The effect from freezing is less in the second than in the first case, since the amount of fluid retained is not so much. Therefore turn the valve down on its side except in rare cases, when the stem [illegible]rudes into space needed for other [illegible]s. This discussion applies only to [illegible] valves.

Lugs on Stationary Boilers.

In the design of a stationary tubular boiler the best means of support should be carefully considered. If the boiler is to be set with a half-arch front, as shown in Fig. 3, and the rear end is to be set on a "brick stand," then there is no need to worry about the side lugs used to support a boiler, as shown in Fig. 4.

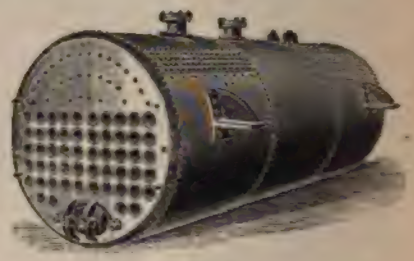


Fig. 4.

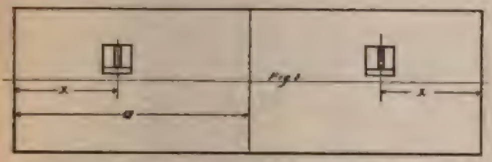
These lugs carry quite a load, for in addition to the boiler shell they have the water, piping and boiler covering and oftentimes the smokestack. The front wall of the boiler setting may be considered as supporting some of the weight.

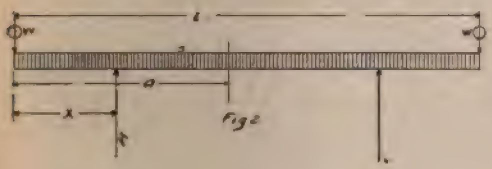
Mr. James Clark, in *Ryerson's Monthly*, says:

"The object of this article is to give the derivation of the formula for the placing of lugs on horizontal tubular boilers in such a manner that there is no bending moment at the girth seams, consequently no strain on the joint due to being supported on the side brackets. I am of the opinion that four good brackets are enough on any stationary boiler, but these should be large where they rivet on the shell in order to distribute the rivets over a considerable portion of the shell, and not cause too much local stress.

"The sketch, Fig. 1, represents a boiler of length L, with seam distance A from one end, the lugs are in distance X from the same end, and when in this position the bending moment at the seam is zero. Now this condition is analogous to that of a beam loaded with a weight W at each end, and a uniform load S extending the length of the beam; the weight W equals the weight of one head and one-half the weight of the tubes, the uniform load S equals the weight of shell and the weight of water the boiler contains when in use (usually about six inches above tubes), divided by the length of

boiler. This condition is represented in Fig. 2. P_1 and P_2 are the supports, and they are to be placed in such positions that the bending moment at any section distant A from the end is zero, the distance in from end is X. From the conditions of symmetry P_1 and P_2 are equal





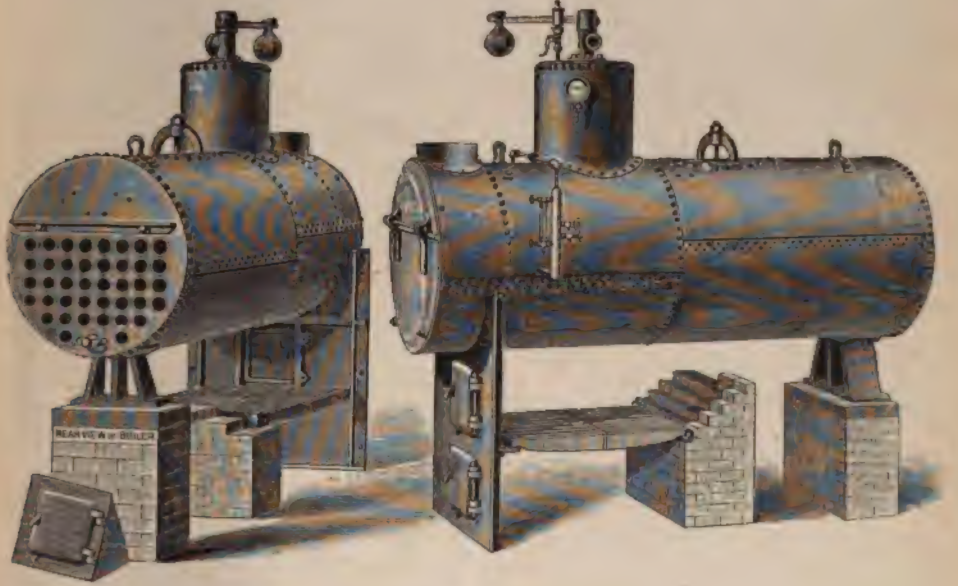


Fig. 3.

and each are equal to

$$\left\{ W + \frac{SL}{2} \right\}$$

or one-half the total weight. The bending moment M at any section distant A from the end equals

$$P_1 \left\{ A - X \right\} - \left\{ WA + \frac{A^2 S}{2} \right\}.$$

and as this expression must equal zero to fulfill the conditions we will substitute the value of P_1 and place the resulting expression equal to zero and solve for X, and we have

$$\left\{ \frac{W + SL}{2} \right\} \left\{ A - X \right\} - \left\{ WA + \frac{A^2 S}{2} \right\} = 0$$

$$(2W+SL) \ (A-X) = 2WA + A^2 S$$

$$\left\{ A - X \right\} = \frac{2WA + A^2 S}{2W+SL}$$

$$X = A - \frac{2WA + A^2 S}{2W+SL} = \frac{ASL - A^2 S}{2W+SL}$$

And for two ring boilers A equals $\frac{L}{2}$ generally, and the expression becomes

$$\frac{L^2 S}{4 \ (2W+SL)}.$$

"And for three ring boilers A equals $\frac{L}{3}$, and the expression becomes

$$\frac{2L^2 S}{9(2W+SL)}$$

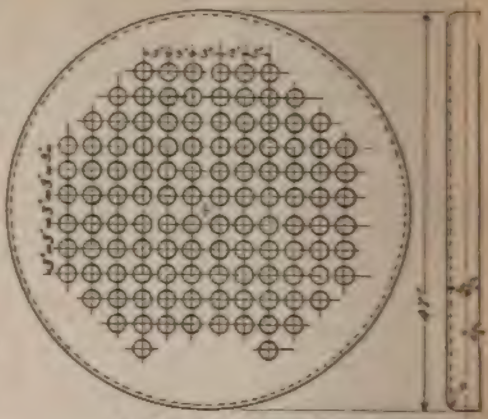
"In the expressions given, S is the only value hard to determine, as it necessitates calculating the volume of water the boiler contains when in use."

Some Boiler Heads.

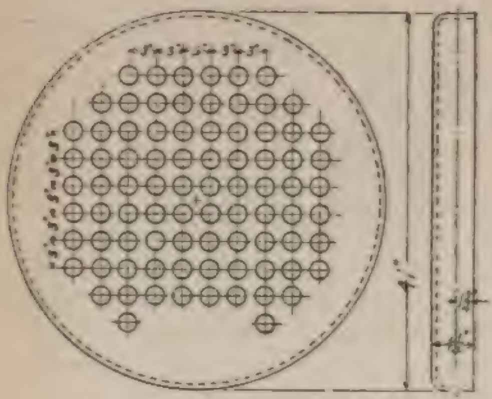
Our illustrations show the lay-out of tubes in boiler heads of 36, 41 and 47 inches in diameter. It will be noted that the arrangement is the same in all of them, and that there are the same number in the 36" and 41" sizes.

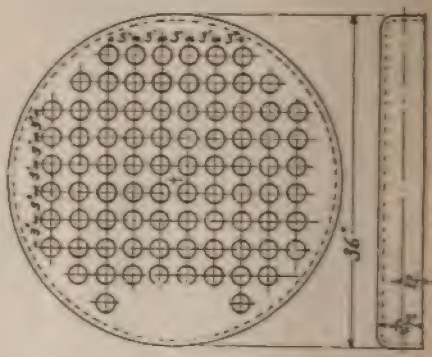
The heads are all $\frac{5}{8}$" thick, rivet holes $\frac{13}{16}$", and the pitch is practically 2".

It appears that the 36" size is rather crowded, and that the other two are about right. The tube holes are 2", thus allowing 1" metal between each of the holes. The radius R for the outside curve is $1\frac{1}{2}$", which in this case would be four times the thickness.



Head $\frac{5}{8}$" Thick. Rivet Holes $\frac{13}{16}$". Pitch 2".





Civil Service Examination.

The United States Civil Service Commission announces an examination on Oct. 4-5-6, 1905, to secure eligibles to fill five vacancies in the position of mechanical draftsman in the Ordnance Department at Large, at salaries of $1,000 to $1,200 per annum. As the commission has experienced considerable difficulty in securing eligibles for this position, qualified persons are urged to enter the examination.

Applicants whose applications show them to be otherwise eligible will be admitted to this examination regardless of the training and experience shown. The training and experience claimed by them will be given consideration before the rating of their examination papers, and if they receive a rating of less than 70 per cent for training and experience their examination papers will not be rated. Persons who have not had the required training and experience should not apply for this examination. Applicants should apply for Form No. 1312, and give the same title as used in this notice.

ELECTRICAL.

Helpful Knowledge About Electricity.

By EDMUND B. MOORE,
Author of "Wire and Wireless Telegraphy."

BEGINNING with this article it will be the writer's aim to give the reader a general idea of the elementary steps in Electricity, to give simple illustrations of the most important and useful functions employed as they continually come upon us in our every-day life.

I wish to state here that technical terms will be avoided as far as it will be possible, and whenever presented will be fully and carefully explained. The language herein employed will be of the simplest kind, and throughout the entire selection it will always be borne in mind that the readers have no previous knowledge of the subject, but wish to become familiar with the general principles and theories without going deep into its mysteries at large. If the reader will carefully and intelligently follow them to the end, I can assure him that he will have attained a general, all-round practical knowledge of this subject, and that it will greatly benefit him in his future every-day life.

THE AUTHOR.

PART I.

As far back as 600 B. C. it was known that when a piece of sealing wax or amber was rubbed with flannel it would attract small particles of paper, gold-leaf, etc., and when the hand was brought sufficiently near the excited or charged amber, small sparks were visible. Now the Latin word for amber is *electron*, and this peculiar force which would attract and repel other light bodies was called *electricity*, because it was first noticed in the excited piece of amber.

The original discovery of this property of the amber is given to a Greek philosopher named Thales, then one of the seven wise men of Greece. The word "electric" was first used by Dr. Gilbert, one of the greatest scientists of the Elizabethan age, in a book published about 1600. It was herein used to point out the attraction of light bodies, which were exhibited in such substances as amber when briskly rubbed.

Now, if we take a rod of vulcanite rubber and rub it briskly with fur for a few moments, then approach one end to small pieces of paper or a pitch ball, we will see that these are immediately attracted. This proves that the rubber has been electrified or charged with a certain kind of electricity.

We will now take a glass rod and rub it as before, only instead of using fur we will take a piece of silk. Upon bringing the end of the glass rod near to the pitch ball it will immediately repel. As with the rubber rod, the glass has been

charged with electricity, but certainly it must be of a different nature, because the first attracts the pitch ball, and the second repels.

These two simple experiments prove to us that electricity presents itself in two different forms, which are called *positive* electricity and *negative* electricity. The electricity produced by rubbing the rubber with the fur is Negative electricity, while the glass rubbed with the silk is Positive.

Now, when the negative charge was brought sufficiently near to the pitch ball it was attracted, and was also charged with negative electricity of the same kind existing upon the electrified rubber. Upon bringing the positively charged glass rod near to the negatively charged pitch ball, it is immediately attracted, because the pitch ball has been charged from the rubber, and this contains an opposite kind of electricity from that on the glass. This proves to us that bodies charged with opposite kinds of electricity, or positive and negative respectively, will attract each other, and that bodies charged wifh the same kind repel. That is, opposite kinds attract and like kinds repel.

It would be well to state here before continuing further, that when a positive charge is made, an equal charge is also made, or vice versa. In the case of the rubber rod when rubbed with the fur, a negative charge is contained upon the rod and an equally positive charge is contained upon the fur. This also holds true with the glass rod; a positive charge is collected upon the rod, while the equal negative charge is collected upon the silk.

We may prove this by bringing the fur used in electrifying the rubber near a positively charged pitch ball, which will be readily repelled, for as we know ·pitch ball contains positive electricity. Then the fur must contain positive electricity, as like kinds repel.

As has been previously shown, upon bringing a charged body in contact with one uncharged, the latter immediately becomes charged with the same kind of electricity as was present upon the charging body. This process is called charging by contact.

Now, if we present an insulated charged body near but not touching an uncharged body, also insulated, upon approaching another charged body we shall find that the uncharged or natural one has become electrified. This is said to have taken place by induction, and the charge upon the ball is termed an induced charge.

The presence of a charge may be determined as heretofore stated by the attraction and repulsion of a charged pitch ball. A number of instruments are now upon the market to answer this purpose, but the simplest, most sensitive and most reliable is known as the Electroscope.

Fig. 1- Electroscope.

This consists of two narrow strips of ordinary gold leaf attached to the lower end of a brass rod. These leaves are then hung in a glass bottle to insure perfect insulation from the ground and to protect them from injury.

If we wish to detect a charge, we will first electrify the leaves by bringing sufficiently near to the top of the brass rod a negatively charged rod of rubber. The charge will pass from the rubber to the top of the brass rod by induction. This charge will be positive, while at the lower end of the rod the charge will be negative. Thus the two strips of gold leaf being charged with the same kind of

electricity (negative) will repel.

If we now bring a supposed charged body near the top of the brass rod and the leaves of the electroscope regain their original position, we know that the body brought near the brass rod was charged with positive electricity, and the two charges—one negative on the leaves, and one positive on the body,—equalize themselves, therefore discharging the instrument. Supposing that the body contained a negative charge, it would then increase the negative charge of the leaves, and they would diverge still farther part. If one wishes to quickly discharge the electroscope, place the fingers upon the brass rod, and the electricity contained therein will pass through the body to the ground.

There is one interesting thing about electricity produced by friction, or strictly speaking, Static Electricity, that should not be passed over, namely, that the electricity produced by friction always collects upon the surface of the object and generally upon the outer surface, such as a hollow sphere, etc. If we have a hollow cylinder and charge it with a quantity of electricity by bringing the brass rod of the electroscope to the under side, we see that the leaves are not disturbed in the least, showing that the inner surface contained none of the charge; but upon placing the rod in contact with the outer coating, the appearance of the charge will be immediately shown by the diversion of the leaves.

The amount of electricity produced by friction is practically very small, and it is often necessary to collect the charges into a large one. This is done by the aid of the condenser or Leyden jar, which consists in its simplest form of a glass jar coated inside and out with a layer of tin-foil. The inside and outside layers respectively are the collecting plates, and the space between these layers, or the intervening glass, is technically termed the dielectric. It is strange, but the charge of electricity in the Leyden jar does not remain upon the two layers of tin-foil, but remains on the surface of the glass. A Leyden jar may be charged to its fullest capacity and the two layers removed, new layers placed in their position, and still the jar is electrically charged as before. The discharging of a Leyden jar is done by connecting the two coatings of foil and regaining an equalibration between the positive and negative charges of the jar. This is often done by the hands with smaller jars, but if a series are used, what are known as discharging tongs should be employed. They consist of a wire having an insulated handle and the wire being of the proper shape so that both coatings may be touched at the same time, allowing the charge to pass through the wire instead of through the body. The Leyden jar was invented by Musschenbrock of Leyden in the year 1745.

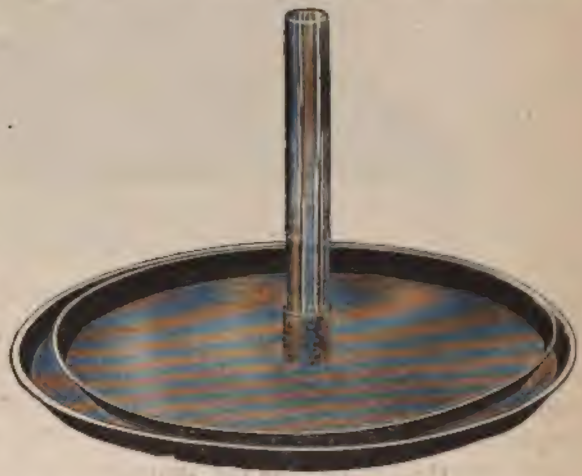


Fig. 2. Electrophorus.

One of the important instruments used in experimenting with frictional electricity is known as the Electrophorus, and

its principle depends upon the laws just described in regard to charging a body by induction.

The instrument consists of a vulcanite rubber plate, which we will suppose is charged with negative electricity. We now hold in our hand a metal disk having an insulated handle, and by grasping the insulated handle and placing the disk upon the negatively charged sheet of rubber, induction at once occurs, and the top of the metal will have become charged with negative electricity, and the under side or the side in contact with the negatively charged sheet of rubber will become positively charged.

If we wish to have the metal disk contain positive electricity only, place the fingers upon the plate, thereby connecting it with the ground, and the induced negative charge will pass through the body to the ground. Now, by removing the disk or plate by the insulated handle we find that it contains a positive charge of electricity. If the charge in the metal plate is neutralized in any way we may repeat the same operation over and over again without greatly diminishing the original negative charge upon the rubber plate.

Many times while experimenting it is necessary to obtain a large amount of electricity, and to do this by the charging and discharging of the metal plate would be very tiresome and even a very slow process. To overcome this, a machine is used which is termed an Electric Static machine. The style and type of these machines vary slightly because of the ideas of the different inventors. * All these machines consist of a process whereby the electrophorus is continually mechanically made.

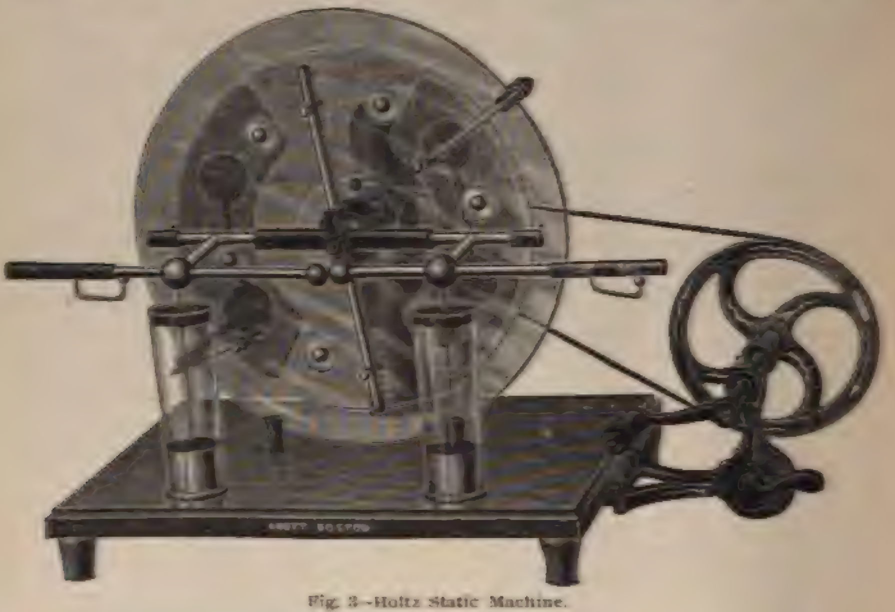


Fig. 3—Holtz Static Machine.

Roughly speaking, the machine consists of two concentric cylinders of glass, the smaller one being allowed to rotate while the larger one is held in a fixed position. Upon the smaller plate are small strips of tin-foil which as they are rotated come in contact with two wire brushes, these being electricallly con-

* The one generally shown, and in fact the most successful, is called the Holtz Induction Machine from the inventor.

[illegible]

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STRUCTURAL.

Standard Specifications.

—FOR—

BUILDINGS, BRIDGES, FRAMEWORK, MACHINERY, ETC.

(Continued from August number.)

48. Dressing, Setting, etc. In all cases for either the ashlar masonry or the rubble masonry, the stones must be so hewn and dressed that when built into the wall they will rest upon their natural beds. Care will be taken that no stones are built in which have cracks or other defects.

49. Centering. Where centering is required for arches, the contractor will provide and set same, and these centers will not be struck before the mortar is thoroughly set.

50. Sand. All sand used for mortar will be clear sharp sand, and in no case will be taken from the seashore or other saltwater banks, nor shall it contain any loam, earth, or dirt.

Where required, the sand will be washed.

51. Cement. All cement used will be of a brand approved by .... well burned and finely ground, and will have been manufactured at such recent date as to be satisfactory to .... or their representa-atmosphere. If the cement used is to have a specified tensile and tive. No cement will be used which has been exposed to the crushing strength, the same will be called for on the detail specifications and drawings, and briquettes of the cement so furnished will develop the required strength when tested in the proper testing machine.

52. Cement Mortar. Cement mortar will be mixed in the following proportions: For brick work and stone masonry, one part of hydraulic cement

to three parts of clean sharp sand.

For concrete work, the cement may be mixed with from one to four parts of clean sharp sand in the proportion specified on drawings.

In all cases, all cement mortar will be freshly mixed just prior to being used, and in no case will any mortar be used which has in the slightest degree begun to set.

. Lime Mortar.

Lime mortar will be mixed in the following proportions: One part of freshly slacked, well burned lime, and 2.5 to 3 parts of clean sharp sand. The lime for the mortar will be slacked at least one day before it is mixed with the sand, and then the sand and lime will be thoroughly well mixed, and before using will be allowed to stand forty-eight hours.

Care to be taken in the mixing of mortar that too much water is not used, and also that the lime shall not be stirred while it is slacking.

. Concrete.

Concrete for footing courses, foundations, and walls or other places where specified on drawings, will be made up of clean broken stone or broken hard-burned brick. In any case the stone or brick will be of such size that every piece used will pass freely through a ring 2½ inches diameter.

Where the contract for the work allows gravel to be used in making concrete, the gravel will be clean, well washed, and free from loam or earth. The broken stone, brick or gravel shall be well and thoroughly mixed and incorporated with cement mortar mixed in the proportion specified, the mixing to be done just before the concrete is placed in position. The concrete is to be deposited in layers of not more than 6 inches in thickness, and each layer thoroughly rammed until it is flushed on the top with water.

Before the construction of any block of concrete is begun, sufficient material for the entire block will be on hand, and when the making up of the block is once begun it will be continued until the block is finished. Where necessary, unless otherwise directed, boxes or other forms or bulkheads for the concrete to be made in or rammed against, will be provided in order to enable the concrete to be thoroughly rammed; these boxes or bulkheads to be provided and set by the contractor. The exterior exposed surface of all the concrete is to be well and thoroughly slushed with fresh cement mortar, and neatly troweled.

55. Samples. The contractor will supply samples of brick, stone, sand. cement, etc., with his proposal. He will also specify from what quarries and factories they are to be produced or what brands they will be, and the same will be subject to the approval of ....

56. Anchor Bolts and Washers. The steel works contractor will furnish the anchor bolts and washers. The mason contractor will include in his price the setting of the anchor bolts and drilling of all necessary holes in the cap stones for the anchor bolts. In general, the holes for anchor bolts will be at least 1 inch larger in diameter than the bolts, so that after the piers are built the bolts can be accurately lined up; and after the mason contractor has lined up the bolts to exact and proper position, then the holes around the anchor bolts will be well filled with fresh cement grout, so that the bolts are firmly held in the exact position.

57. Excavating. All necessary excavations for the foundations are to be done by the excavating contractor to the exact lines and levels given: and should the nature of the ground require shoring in order to maintain the proper openings while the masonry is being built, the contractor for the excavating shall provide and set such shoring, well and thoroughly bracing and staying the same. The contractor for the excavating will take care that the bottoms of the excavations are on the proper lines to allow the bottoms to be thoroughly and well rammed over the given areas of the footing courses, and will include in his price for the excavating the ramming of the surfaces, so that footing courses will be started on sound, hard ground. All stones or other obstructions to the excavating will be removed by the excavating contractor and the openings left clean and free from obstructions. Should quicksand or water be encountered in the excavating, the removal of same will be made the subject of a special contract.

58. Back-Filling. After all foundations are in place and the cement or mortar thoroughly set, the contractor will back-fill to the proper level. This back-filling will be thoroughly rammed and sluiced into a compact mass to provide against as little future settlement as possible. This back-filling is to be brought up to the proper levels, as shown on the drawings.

MACHINERY.

59. Iron Castings All iron castings will be of tough gray iron free from injurious cold shuts or blow holes, true to pattern, and of a workmanlike

finish. Sample pieces 1 inch square cast from the same heat and cast in sand molds will be capable of sustaining on a clear span of 4 feet 8 inches a central load of 500 lbs. when tested in the rough bar. The number of these sample pieces and the part of the heat from which they are taken, will be specified by the inspector. All chilled castings will be chilled to the depth specified in the general specifications or on the drawings. There shall be sufficient backing to the chilled portion of tough gray iron to give ample and sufficient strength to the casting. In large castings care must be taken that they are not allowed to cool too slowly, so that the crystallization may be as evenly distributed throughout its mass as possible.

0. Steel Castings.

All steel castings will be made from tough metal manufactured by the open-hearth process, and will have an ultimate strength and chemical analysis best adapted to their requirements.

If required, a copy of the chemical analysis and tests of each heat from which castings are made must be forwarded to .... All large castings will have a test-piece cast with them; these test-pieces to be $1\frac{1}{8}$ inches square by 12 inches long.

1. Shafting.

All shafting will be either cold rolled or turned, as specified on drawings, and shall be perfectly straight and true to gauge. All key-ways are to be accurately cut to dimensions shown on drawings and keys are to be neatly and tightly driven.

2. Forgings.

All forgings are to be of material specified. Before forging, the material must be thoroughly and equally heated throughout its mass. All enlarged ends are to be formed by upsetting, welding to be dispensed with as much as possible. After the forgings are complete they are to be thoroughly annealed. All forgings are to be neatly finished, and in dies when so required, and to be done in neat, workmanlike manner.

3. Bearings.

All bearings are to be of a material specified and of a brand approved by .... Before babbiting, all bearings are to be thoroughly heated so that the material will equally fill the space around the shaft.

4. Chains.

Where chains are called for they will be of a brand and manufacture approved by .... They shall have been tested with a proof load and one and one-half the working load.

65. Wire Rope. All wire rope will be of a standard and reliable brand approved by ....

66. Painting. All machines will be painted as specified on the drawings or as called for in the general specification. All finished parts or machined surfaces will be given a coat of pure while lead mixed in tallow before shipment. Where not otherwise called for the paint will be as specified for structural steel and iron work. Paragraph 32.

67. workmanship and Material. In general the workmanship and material will be strictly first-class in every respect and done to the approval of ....

HOME STUDY.

Machine Design.

CHAPTER XII.

Tooth Gearing.

(*Continued from August number.*)

THE next thing the designer wishes after discussing the form of the teeth is the strength of them. In devising a formula for the strength of gear teeth, there are two cases to consider: First, where all the pressure on a tooth comes on one corner, as in Fig. 1, and secondly, where the pressure is uniformly distributed along the whole width (b) of the tooth as in Fig. 2.

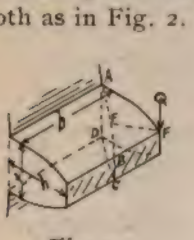


Fig. 1.

Fig. 2.

The pressure is liable to act on a corner of the tooth when the teeth are inaccurately constructed, or when the axes of the gears are not properly located.

In gearing that is carefully constructed and on shafting properly adjusted, the contact will be along the whole width of the tooth, and hence transmit more power than otherwise.

Of course, after a time the bearings and supports will wear some, as it is not always safe to assume that the pressure on the teeth is uniform.

When the load (Q) on a tooth acts at one corner, as in Fig. 1, it may be shown that the tooth will give away at a section (ABCD) which makes 45° with its root, provided the width be not less than the length or height h.

Let EF be perpendicular from F to AB. Then EF = AF = EB. Let each be represented by s, then AB $= 2s$. The bending moment of Q, with reference to the section ABCD, $= Qs$, and assuming the tooth to be rectangular, the moment of resistance is $\frac{1}{6} \times 2st^2f$ where f is the strength of the material. Equating the bending moment to the moment of resistance, we get the relation

$$Qs = \frac{1}{6} \times 2st^2f \text{ or} \qquad (1)$$

$$Q = \frac{t^2f}{3} \text{ and } t^2 = \frac{3Q}{f} \qquad (2)$$

which shows that the length or height of a tooth does not effect its strength if the load acts at one corner.

Since t is usually given in terms of the pitch, we will substitute for t in the above formula its value in terms of p, the pitch.

From the table given in the article on this subject in the August issue we have

given the value of t as variable according to the different authors, but averaging $.473\,p$. Allowing for wear, say to $.4\,p$, then (2) becomes—

$$.16p^2 = \frac{3Q}{f}$$

The load Q on the tooth may be taken as $\frac{3}{8}$ P where p is the driving force at the pitch line, calculated from the horse-power and speed. The strength f may be taken at from 2,500 to 4,500 pounds per sq. in.

Taking $f = 3{,}500$ and $Q = \frac{3}{8}P$, we get the above in form thus: $p = .06\sqrt{P}$ and $P = 280\,p^2$.

Taking up the case as shown in Fig. 2, we have the moment of resistance to bending equal to $\frac{1}{6}bt^2f$, and the bending moment equal to Qh. Hence, $Qh = \frac{1}{6}bt^2f$, in which we may put $t = .4p$, and $Q = \frac{3}{8}$ P as before, and $h = .7p$. Then

$$P = .0571\ bpf, \text{ and } P = \frac{17.5\ P}{bf}$$

And putting $f = 3{,}500$, we get $P = 200bp$, and $p = \frac{P}{200\ b}$, but b is generally expressed in terms of p, let $b = np$, then $P = 200np^2$ and $p = \sqrt{\frac{P}{200\ n}}$ The dimension b varies from two to three times the pitch (p), and is often taken $2\frac{1}{2}\,p$ for the medium sizes of gears, hence n would average $2\frac{1}{4}$ for most cases.

The following table, taken from the Walker Mfg. Co., will show what has been used for b in this respect :—

PITCH (Circular)	SPUR GEAR	SPUR RACK	BEVEL GEAR	MORTISE WHEELS
½	1¼	1¼	1¼	
⅝	1½	1½	1½	
¾	1¾	1¾	1¾	
⅞	2	2	2	
1	2½	2½	2½	
1⅛	3	3	3	
1¼	3½	3½	3¼	
1⅜	4	4	3½	
1½	4½	4½	4	5
1⅝	5	5	4½	5½
1¾	5½	5½	5	6
1⅞	5½	5½	5¼	6½
2	6	6	5½	7
2⅛	6½	6½	6	7½
2¼	7	7	6¼	8
2⅜	7	7	6½	8½
2½	7½	7½	7	9
2⅝	7½	7½	7	9½
2¾	8	8	7½	10
2⅞	8½	8½	8	10½
3	9	9	8¼	11
3⅛	9	9	8½	11½
3¼	9½	9½	9	12
3⅜	10	10	9½	12½
3½	10½	10½	10	13
3⅝	10½	10½	10	13½
3¾	11	11	10¼	14
3⅞	11½	11	10½	14½
4	12	12	11	15
4¼	13	13	11½	16
4½	14	14	12	17
4¾	15	15	13	18
5	16	16	14	19

SHROUDING GEAR TEETH.

In order to strengthen gear teeth the rim is wider than the teeth and carried outward, as shown in Figs. 3, 4 and 5.

Fig. 3. Fig. 4. Fig. 5.

The *shrouding*, as it is called, may extend out to the point of the tooth, or half way out, or entirely out on only one end of the teeth.

In the first case the mating gear or rack can have no shroud on it, but in the second and third case both gears or the gear and rack are equally proportioned. Teeth which are not thicker at the base or root than at the pitch line are greatly benefited by shrouding. The advantage of shrouding is greater the narrower the wheel.

When gears are nearly the same diameter, the shrouding should extend to the pitch line on both ; but when one is very much larger than the other, it is the best practice to shroud the smaller one only, because the teeth on the smaller one is of weaker form, and the wear is greater here, too.

FILLET AT ROOT OF TOOTH.

This part of the tooth is not arbitrary, and it is here suggested that the radius of the fillet be equal to one-sixth the width of space between adjacent teeth measured at the circumference of the addendum circle, as shown in Fig. 6.

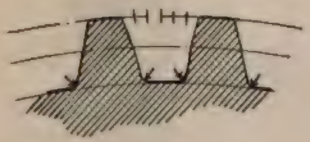


Fig. 6.

RELATIVE PITCHES OF TEETH
OF EQUAL STRENGTH FOR DIFFERENT MATERIAL.

The following table gives the relative pitches of the teeth of gears made of various materials, on the assumption that the teeth are proportioned according to the same rules in each case :—

Material.	Relative Pitches.
Cast Iron	1.0
Wrought Iron	0.6
Steel	0.5
Wood	1 3
Gun Metal	0.8

SPEED OF TOOTHED GEARING.

The speed of a gear is figured at the pitch line, and is expressed in *feet per minute*.

Prof. Unwin states that the maximum safe speed for cast iron spur gears does exceed 96 feet per second, or 5,760 feet per minute on the pitch line.

Low and Bevis in their Machine Design give the following :—

Ordinary cast iron gears	1800 ft per min.
Helical " "	2400 " "
Mortised " "	2400 " "
Ordinary cast steel "	2600 " "
Helical " "	3000 " "
Spec. cast iron mach. cut gears	3000 " "

They refer to a case of a cast iron gear running 4,712 per minute on the pitch line, the gear being 30 ft. in diameter.

HORSE POWER OF GEARS.

The horse power of gears is rather a myth, because little information is at hand from which to deduce a formula, but it is evident that since horse power is made up of two factors — speed and weight — that the same may be applied to gears.

Let P = driving force at the pitch line in pounds.

D = Diameter of pitch circle in inches.

$\frac{D}{12}$ = " " " in feet.

V = Velocity in feet per minute on pitch line.

N = Number of revolutions of gear per minute.

H = Horse power.

33,000 = number foot-pounds in one minute = one horse power.

Then

$$\frac{PV}{33000} = H.$$

$$\frac{3.1416\,D \times N}{12} = \text{Speed in feet per minute} = V.$$

$$H = \frac{P \times \frac{3.1416\,DN}{12}}{33000} = \frac{P \times 3.1416\,DN}{33000 \times 12}$$

$$P = \frac{33000\,H}{V}$$

and from the above, $P = 280\,p^2$, then

$$280\,p^2 = \frac{33000\,H}{V} \text{ or}$$

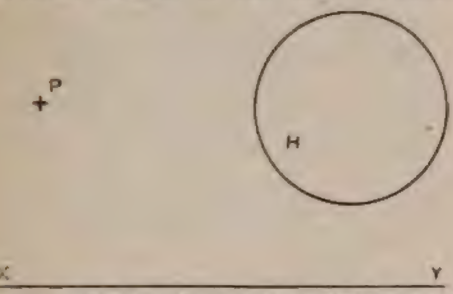
$$H = .0085p^2V = .0022p^2DN.$$

The Problem of Line, Circle and Point.

We have received two answers to the following problem which appeared in our August issue: To draw a circle through the point P and tangent to the circle H and the line XY.

One answer gave a solution that resulted in passing a circle through P and tangent to XY, but nothing was said about the circle.

The other assumed a point on the circle, calling it H, and his sketch showed a circle passing through P and tangent to the circle and XY. By trying this method we find that we could not draw the circle tangent to the circle without



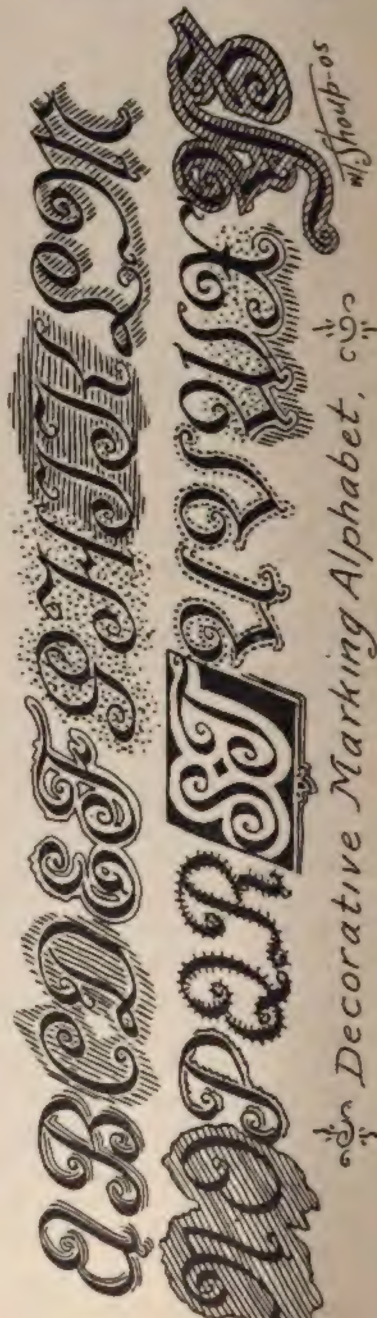
very careful location of the point H, and then we were not sure of it when it was drawn. By changing H we had a different result every time.

Try it again, and let us see the solutions.

Cost of Solomon's Temple.

Even in these days of extravagance and millionaire display, very few people have any adequate impression of the immense cost of the great temple of Solomon at Jerusalem, the site of which is undoubtedly occupied by the splendid Mosque of Omar, a Saracenic building of exquisite beauty, of octagonal form and of great height, surmounted by a dome. It is built of marble and is of pale blue color, the platform on which it stands being of a dazzling white. In the building of Solomon's Temple the preparation of the materials, the cost of labor, etc., the cost was really wonderful. For example, there were 80,000 men employed as hewers of stone, 60,000 bearers of burdens, 10,000 hewers of cedars, 3,300 overseers, all of whom were employed for seven years, and upon whom, besides their wages, Solomon bestowed £8,773,970. If their daily food was worth 2s. each, the total sum for all was £63,877,088 during the time of building. The materials in the rough are estimated as having been worth £2,545,377,000, and the total cost of the building is placed at the enormous sum of £6,879,822,000 sterling.—Record and Guide.

Some Fancy Lettering.



CURRENT TOPICS.

SOMEONE has said that a person is just as old as he is in experience.

THE way some draftsmen move around we think they must be quite aged, but we try to keep the changes of their address up to date. Don't be afraid to send them in. We want to have the magazine go regularly.

SEVERAL replies to our free offer, printed in the August issue, have come in, one for information as to sketches desired. These should be on tracing cloth or white paper similar to bristol board. The ordinary letter paper without lines will answer quite well enough. These sketches should be about 3x4, 5x8, or 6x10. The former will reduce to single column, the next to double column, and the latter to page size.

DID you notice the "ad." in this issue of the "Universal Sketching Paper"? It is something new, a departure from the old-time section line paper, but having all the advantages and some more. The surface has no lines upon it, but is covered with dots arranged in rows ⅛" apart, the eighth one being a trifle heavier to denote the inch. With these points as guides, one may draw light, heavy, dotted or broken lines without confusion as is the case on ordinary section line paper. When a blue print is desired of the sketches, no lines show except those of the drawing. A good lead pencil sketch was blue-printed in three minutes, but the dots showed a trifle, yet in no way interfering with the sketch lines.

How many of our draftsmen have business cards? There may be some people who think it is unnecessary, but there are times when such a card is quite an introduction. There is no harm in having your occupation printed under your name on a neat card with the address. One that has come to our notice is here reproduced in arrangement, but not in exact style of type, and we wish to say that it is quite neat. It might be better to say, "Experienced Mechanical and Architectural Draftsman," or it might be arranged as in Fig. 2 or Fig. 3.

HARRY J. STILLSON

EXPERIENCED
MECHANICAL AND ARCHITECTURAL
DRAFTING.

103 Green St, BATTLE CREEK, MICH.

Fig. 1.

Mechanical and Architectural
Drafting.

HARRY J. STILLSON

103 Green St.
BATTLE CREEK, MICH.

Fig. 2.

MECHANICAL ARCHITECTURAL DRAFTING.	
HARRY J. STILLSON	
103 Green St.	BATTLE CREEK, MICH.

Fig. 3.

Why Not Organize?

I am pleased to read the article by A. T. Square, also the editor's advice and generous assistance in this matter, as expressed in the July number. In connection with this I would suggest that a list of names of those willing to become members be placed in a column in THE DRAFTSMAN as charter members.

Now, regarding a plan of procedure, will say that rules and regulations be submitted which you think would be best adapted for our organization, the same to be published in this magazine. Also that a committee be selected from those sending in the best constitution, whose duty it will be to meet and frame the rules, etc. That the editor appoint this committee and the time and place of meeting.

Now, brother, get in the push and send in your name and by-laws.

A PENCIL PUSHER.

More Society Notes.

There are in this country several associations after which the society of draftsmen may be modeled. No doubt the organization of the American Institute of Architects or the Architects' League of America would be of use. Both have branches or chapters in all the larger cities. In the former the branches are called "chapters," while in the latter they are "clubs," and in a few cases having such titles as "The Triangle Club of Denver," "The T-Square Club of Philadelphia," and so on.

Each has a central or national organization which is composed of members of the different chapters, the highest officer of which would necessarily be at the head of the local chapter where he resided as ex-officio to the president of that chapter.

The draftsmen's society should have a national organization and local chapters.

To accomplish this end we have before us a task divided into at least the following heads:

(1) To formulate the object and reasons for such a society.

(2) To interest the men in it and secure their co-operation.

(3) To appoint a committee to draft a constitution which is to be submitted for general discussion.

(4) To form branch societies or chapters of the national body in the various cities where there are a number of draftsmen.

It might be a hard matter to get members of the "profesh" to go to some central point for discussion of the matter, hence it will have to be done through these columns and at local meetings.

Let us propose a Constitution and By-Laws to start the discussion:

CONSTITUTION.

ARTICLE I.

NAME AND OBJECT.

Section 1.—This association shall be known as the ....

Sec. 2.—The objects of this organization shall be: To unite fraternally and socially all persons of good moral character engaged in drafting; to especially train its members in those branches of practical education which have a direct beairng upon the work of drafting; to originate and circulate literature relating to the science of drafting, and to standardize as much as possible; to promote uniformity of drafting office

[illegible]

ARTICLE III

[illegible]

Control, to carry on regular correspondence with the Secretary of the American Society of Draftsmen, and to make such reports to said Secretary as are required. He shall have custody of all books and papers of the chapter, and shall perform such other duties pertaining to his office as may be ordered by the Board of Control. Pursuant to the requirements of the Society, a list of the Board of Control, officers and members of the chapter, with their addresses, shall be transmitted by him to the Secretary of the American Society of Draftsmen annually and whenever required. He shall transmit to the General Secretary a copy of the Constitution, By-Laws and other regulations of the chapter and of all amendments thereto.

Article V.

MEETINGS

Sec. 1.—The annual meeting of the chapters for the election of members of the Board of Control, and for such other business as may be brought before it, shall be held on the second Tuesday in May, or at such other time as may be fixed by resolution of the chapter, the Secretary notifying all members two weeks in advance, stating hour and place of such meeting.

Sec. 2.—The regular meetings of the chapter for educational work shall be held .... a month, beginning in October and continuing until the annual meeting.

Sec. 3.—Special meetings of the members may be called by the President or the Board of Control, or by the President upon receiving a written request for the same from any fifteen members in good standing.

Sec. 4.—At all meetings of the chapter,......... .... active members in good standing as shown by the records of the Secretary and Treasurer, shall constitute a quorum.

Sec. 5.—Roberts' Rules of Order shall be the authority upon parliamentary rules.

Article VI.

AMENDMENTS.

Sec. 1.—The Constitution or By-Laws of this chapter may be amended either by a unanimous vote of the entire Board of Control, or by a two-thirds vote thereof, when three days' written notice of the intention to move the proposed amendment has been given to each member of said Board; or by a three-fourths vote of a quorum at any meeting of the members of the chapter, provided that notice of a motion for the proposed amendment shall have been filed with the Secretary of the chapter and given at he meeting previous to that at which a vote thereon is to be taken. Such amendment shall become effective only after the same shall have been certified by the Secretary of the Society.

BY-LAWS.

Article I.

At all meetings of the chapter the following shall be the order of business :—

First—Reading of minutes of preceding meeting.

Second—Reading of names of applicants for membership.

Third—Reports of special committees.

Fourth—Reports of standing committees.

Fifth—Reading of communications and notices.

Sixth—Reports of officers.

Seventh—General business.

Eighth—Special program.

Ninth—Adjournment.

Article II.

There shall be three Standing Committees appointed by the President with the approval of the Board of Control.

There shall be a Program Committee composed of three or more members, whose duty it shall be to prepare programs for the regular meetings of the chapter

There shall be a Membership Committee composed of three or more members, whose duty it shall be to maintain and increase the membership.

There shall be a Hall Committee composed of two or more members, whose duty it shall be to make all necessary arrangements for obtaining and keeping up a suitable meeting place for the chapter.

Such other committees as may be necessary for carrying on the work of the chapter shall be appointed from time to time in the regular way.

Article III.

These By-Laws may be amended or added to at any regular meeting of the Board of Control by a three-fourths vote of those present, provided that one week's notice of the proposed amendment or addition has been given.

Pamphlets have been made containing the above Constitution and By-Laws. Send for some and distribute them among the draftsmen.

The Automatic Shading Pen.

Although the Automatic Shading Pen has been in use for several years, not until recently has its many advantages and wide field of usefulness become recognized. The reasons for this are many, but perhaps the most potent of all has been the need of an ink exactly suited to the peculiar requirements. This has been accomplished, and the use of the pen greatly increased.

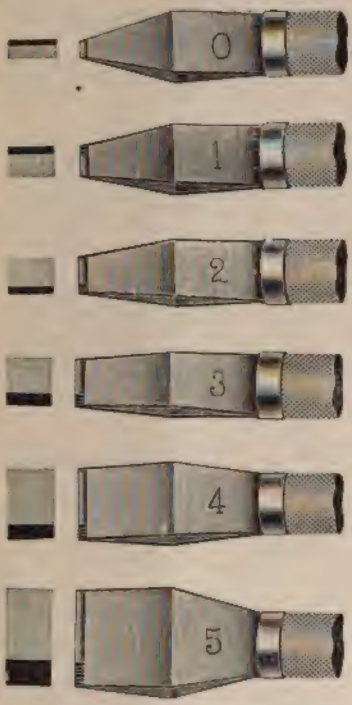


Fig. 1.

This pen is exactly what the name implies. The person holding the pen forms the stroke or letter to be shaded, and the pen automatically does the shading without the assistance of the writer. The pen makes a mark of two different shades at a single stroke, and that color or shade which comes from the right side of the pen must under all circumstances be considered the shade, and the color which comes from the left side, or the side nearest to you, is the main stroke or the stroke forming the letter.

Fine lines are made by sliding the pen edgewise; wide lines by drawing the pen bodily downward or to the right; curved lines by sliding edgewise and around to the right or left and downward. In writing, the downward pressure on the pen should be only sufficient to make the ink flow.

The illustrations show several styles of pens and the actual size of mark made by each. Figs. 1 and 2 are known as No. 100, Fig. 3 as No. 400, and Fig. 5 as a special style of No. 400.

Lettering, like many other arts, is simple if we go at it in the right way. Uniformity of stroke is the chief essential in good lettering. This can be accomplished only by holding the pen in the proper position. By making the stroke in lettering the right length, slant, &c., over and over again, we form a correct habit, and finally make a perfect stroke apparently without effort.

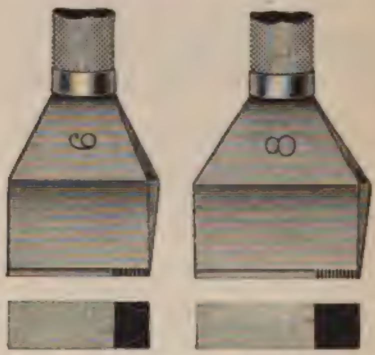


Fig. 2.

If we have a positive guide there is little chance for waste of time or the forming of incorrect habits. Paper has been prepared with lines as shown in Plates A and B.

For a slanting letter the pen should assume such a position that when the lower part is on the corner of the square, the top rests in the center of the square.

The pen never changes from this angle in drawing a slanting stroke, no matter what turns or curves are made.

By placing the lower corner of the pen on the corner of the square, and drawing it down until said corner reaches the center of the square below, you have strokes the same length, distance apart and slant.

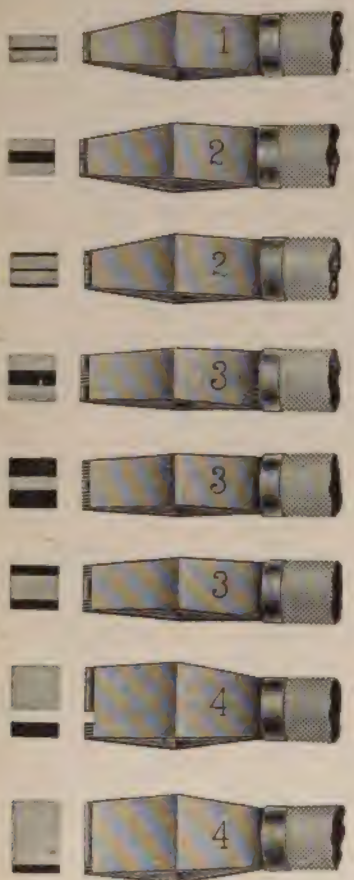


Fig. 3.

The dotted line in Plate A shows the slant of the nib of the pen at the time of beginning and finishing the stroke, which is always the same.

By placing the pen in the position above mentioned, and drawing it to the right one square, you have the proper beginning for nearly every letter in the block alphabet.

Plate B shows the same procedure, except that the pen assumes a slant of 15°, or from corner to corner of the square, instead of from the corner to the center of the square at the top.

A person without any knowledge of lettering whatever, following this method cannot fail to learn within a week to do

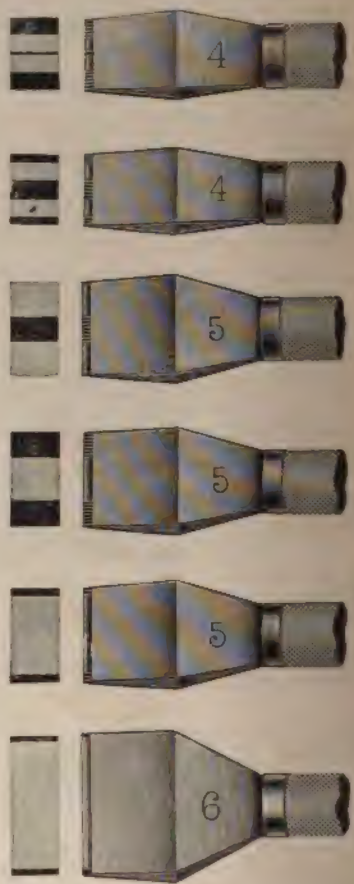


Fig. 4.

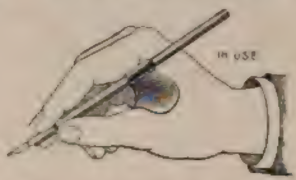
accurate block lettering, slanting or vertical. No better style can be adopted by a draftsman for lettering title sheets over drawings, special cards, notes for shop use, &c., &c., or for work during evenings for the butcher, the baker, and the candlestick-maker.

Outfits for this class of work may be obtained from the Auto Pen and Ink Mfg. Co., Chicago, Ill, who also handle

an elegant work for beginner, teacher and artist. It contains eight pages of copies, sixty pages of alphabets, with a great number of designs, borders, display cards, &c., &c. Price, $1.00, or the alphabetical portion only for 75c.

Do You Need One?

How many draftsmen are poor writers! Perhaps the device illustrated here would be of assistance. It is designed to avoid writers' cramp, and the fact that 20,000 have been sold in the past few



years is evidence that there are lots of people who are afflicted. This may not apply so much to draftsmen as to other penmen. The above firm furnish them.

New Inventions.

The following inventions have been specially reported for THE DRAFTSMAN by C. LeRoy Parker, solicitor of patents, 707 G street, Washington, D. C.

DRAWING TABLE.

No. 794,359. Thomas King. July 11, 1905.

This invention relates to drawing tables, and has for its object to provide for the convenient support of a roll of paper or drawings beneath the top of the table in such a manner as to facilitate the unwinding of the roll and the stretching thereof across the top of the table into position to work thereon when the roll is composed of drawing paper, and to take tracings therefrom when the roll is a roll of drawings, such for instance as maps.

It is a further object of the present invention to embody the same in the nature of an attachment capable of being readily applied to the under side of any ordinary drawing table without altering or chang-

Plate A.

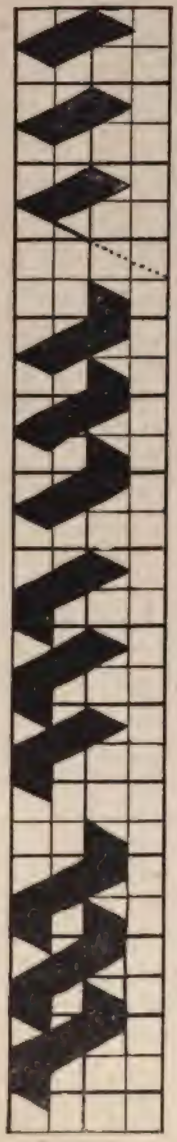


Plate B.

ing the same, and without interfering with the ordinary use thereof.

The drawing table comprises a transverse slot intersecting the top and bottom thereof adjacent to the front edge of the table, spaced guideways provided upon the under side of the table and leading rearwardly from the slot, a pair of brackets slideably hung from the guideways, and provided at their forward ends with seats spaced below the table top, and a roll holder mounted in the seats in substantial parallelism with the slot.

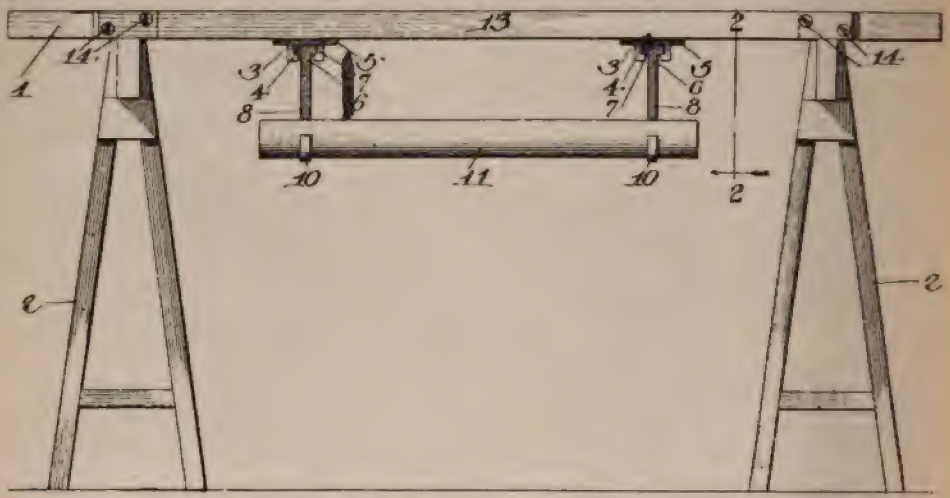


Fig. 1.

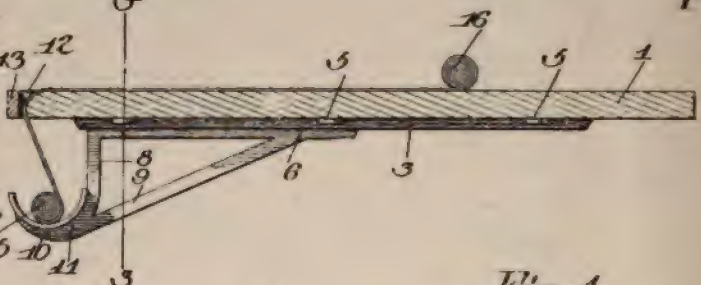


Fig. 2.

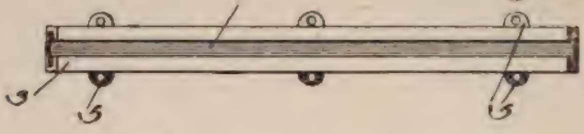


Fig. 4.

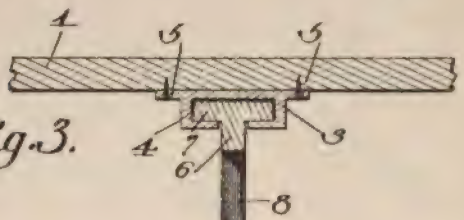


Fig. 3.

PROTRACTOR.

No. 794,569. William L. Thomas, July 11, 1905.

The principal object of this invention

is to provide an instrument of this character adapted for the making of maps on different scales, this object being accomplished by a plurality of rulers graduated at different scales interchangeable one with another, and respectively connected with the arm of the protractor.

Another object of the invention is to provide an improved construction which secures an accurate and direct register of the rule with the degrees of the protractor circle, and affords a continuous rule edge outward from the zero point of the rule at the center of the circle.

Fig. 1.

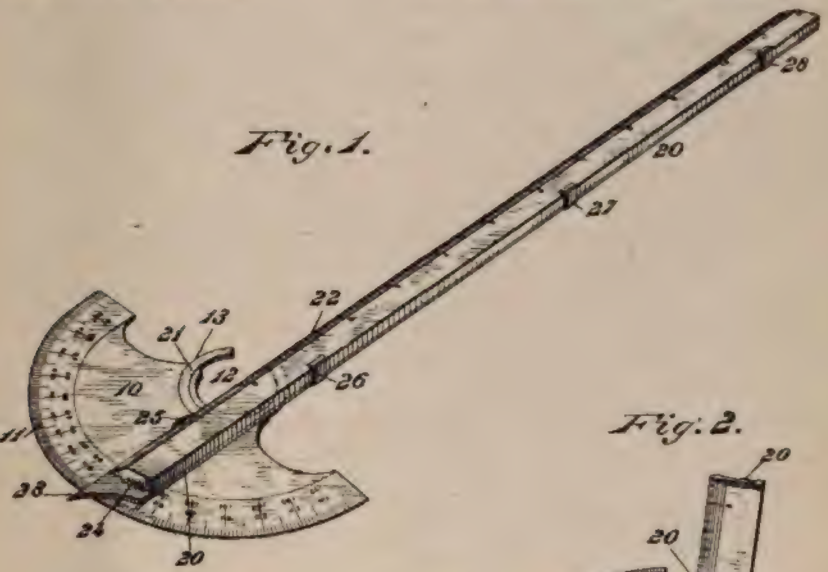


Fig: 2.

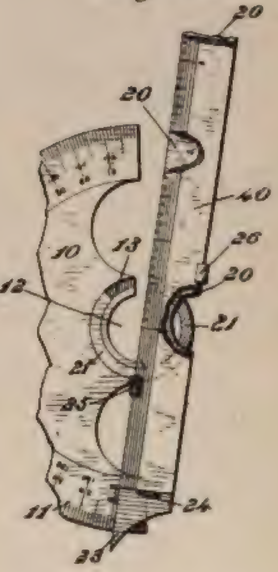


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7

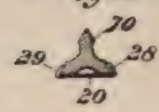
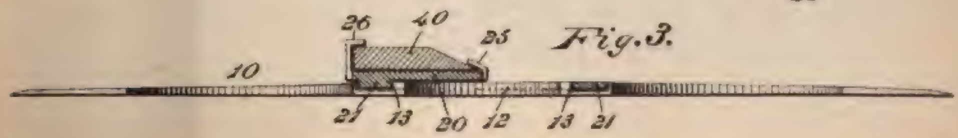


Fig. 3.



The protractor comprises a base plate having a graduated segmental protractor arc extending through a portion only of the protractor circle, an open free space at the center of said circle, and an arc-shaped guide concentric with said arc, and disposed near the center of said protractor circle, a swiveling protractor arm provided with an arc-shaped member adapted to fit said arc-shaped guide, and forming a supporting hub for said arm, said arm comprising a short portion on one side of the circle center adapted to ride over said graduated arc and register directly with the graduations thereof, and a detachable ruler mounted on said swiveling arm, and having a continuous unobstructed ruler edge from said circle center outward on the other side of said center beyond the circumference of said circle and having its zero point disposed always at the circle center.

DRAFTING TABLE.

No. 795,065, George Ring, July 18, 1905.

This invention has relation to drafting tables, and has for its object the provision of a table having novel apertures for facilitating the drawing of perspective views.

In carrying the invention into effect, the inventor produces a flat-topped table of any required size, and upon the table mounts a rectangulnr frame surrounding the table and carrying hinged sliding rules, one of which is adapted to be used in ruling vertical lines and the other in ruling horizontal lines, and at each end of the frame is mounted a bar which is arranged parallel to the end of the frame and which carries a laterally extending sliding rod upon which is mounted an adjustable head, and upon the head at each end of the table is pivotally mounted a ruler or rod, these rulers or rods serving respectively to facilitate the making of the two sets of lines converging to vanishing points which are necessary in making perspective views.

COMPASSES.

No. 795,061, Jacob Pilsatneeks, July 18, 1905.


Fig. 2.


Fig. 3.

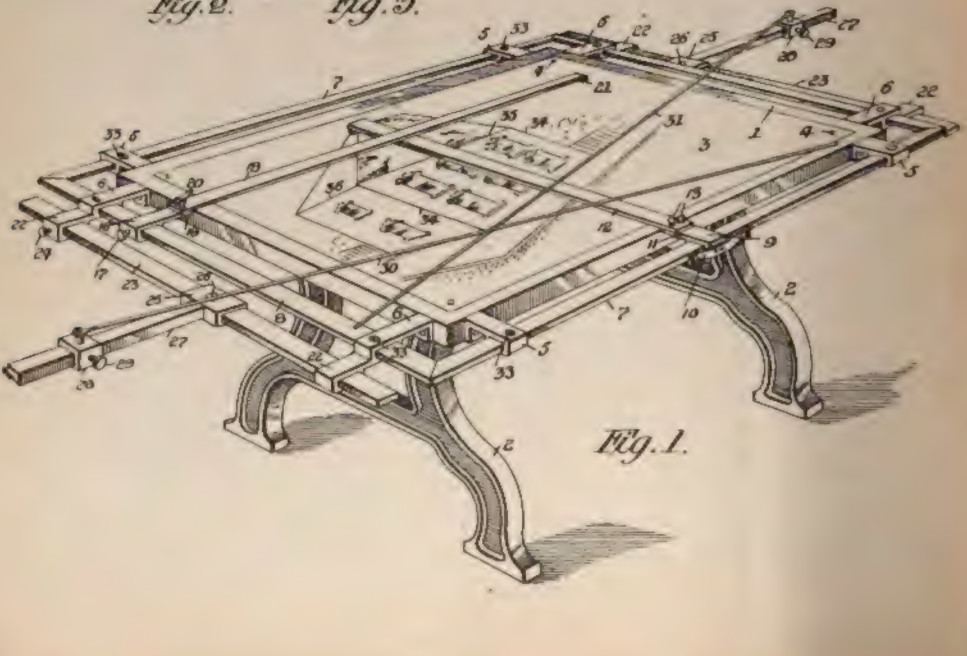
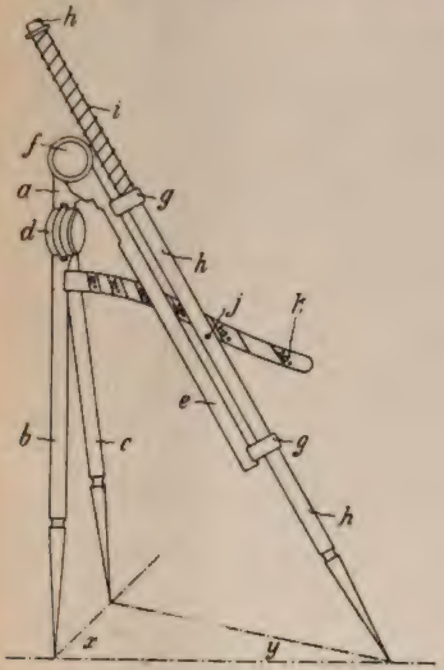


Fig. 1.

Compasses constructed according to this invention have three legs, two of which are adapted to be moved in planes which are perpendicular to each other, one of said legs being capable of prolongation proportionately to the angle of its opening between itself and the third leg, so that it will always form the hypothenuse of a right-angled triangle



of which said third leg is the perpendicular. Preferably the prolongation of the aforesaid leg is effected by means of a curved arm provided upon one of the other legs. This arm may be furnished with a graduation in order to enable any desired acute angle to be set out by the adjustment of the prolongable leg in case the distance between the other legs is constant.

DRAFTSMAN'S TRIANGLE.

No. 795,145, Albert C. Lomis, July 18, 1905.

The objects of this invention are to provide a single triangle for use in connection with a T-square in mechanical drafting, the edges of which will be adjustable with relation to the base of the triangle to enable lines to be drawn at any desired angle, to reduce the need of a plurality of triangles, to provide a comparatively simple and inexpensive con-

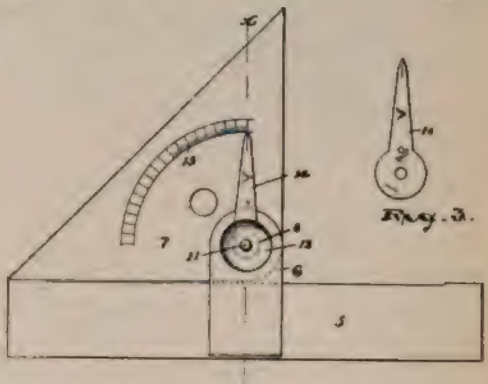


Fig. 3.

Fig. 1.

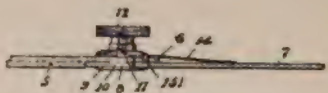


Fig. 2.

struction, and to secure other advantages and results, some of which may be referred to hereinafter in connection with the description of the working parts. The construction of the device is obvious from the illustration.

Civil Service Examination.

The United States Civil Service Commission announces an examination on Sept. 13-14, 1905, to secure eligibles for the positions of constructing engineer for sewers and waterworks at Manilla, P. I., salary $1,400 to $2,000, and copyist topographic draftsman, R. F. D. service comprising the states of Arkansas, Louisiana, Missouri and Texas, salary, $900. Also for an architectural and structural draftsman, at $1,500 per annum, in the Quartermaster's Department at Large, Washington, D. C. Also

for a general mechanic, $720 per annum, at Western Navajo Agency, Arizona, and assistant librarian (male), at $900 per annum, in the Department of Justice.

BOOK REVIEWS.

No doubt many of our readers are familiar with the "Sayings of Joe Cone" which have appeared in these columns from time to time. This gentleman has come along through the stages of farm boy, printer, mill hand, chief draftsman and designer, and instructor of drawing and design.

Born with a love for literature, Mr. Cone has gratified his taste in that direction to the extent of articles in many of the leading magazines, and in a published volume of successful verse, "Heart and Home Ballads," dealing mainly with mill topics.

One of his latest efforts is "The Waybackers," a story of the villiagers of Narrowville. It is unique in that it deals with a character in each chapter especially, and the quaint language and humor are pleasing throughout the book. The work is illustrated by pen sketches of the characters mentioned in the story.

Some verses are attributed to these persons which show characteristics of Mr. Cone's pen. One,—"Lines to a Tailless Dog,"—may illustrate this feature:—

"No dog so poor, no dog so low,
No dog so prone to lag;
No dog so sad as Hutchin's dog,
Who has no tail to wag."

The work is produced in red cloth, 379 pages, 5x7½, by the Colonial Press, Boston, Mass.

A Subway for Freight.

The Merchants' Association of New York has under consideration a subway project for handling freight similar to the one in Chicago, but to be built by the city. It is proposed to build a subway encircling the lower section of the city and connecting the railways in the belief that heavy trucking will not only be eliminated from the streets but that the obstruction of great fleets of tugs and lighters on the bays and rivers will also be relieved in great measure.

Good Reading.

After sorting out the back copies of THE DRAFTSMAN for bound volumesthere remain a few odd numbers, about an equal quantity of the following issues. The more important articles are here given and there are many illustrations to each one.

January, 1902—

Engine Proportions.

Boiler Notes. Dimensions of Keys. Notes on Cranes.

Design of Scissor Trusses. Gas Pipe for Building.

Concerning Beams, I. Standard Connections. Angles. Lettering.

February, 1902—

Engine Governors. Cost of Horsepower. Boiler Bracing.

Concerning Beams II. Numbering Drawings. Drawing Boards. Rivet Heads.

March, 1902—

Arms of the Pulley. Transmission of Power by Ropes.

Rules for making Shop Drawings.
Gauge of Track on Curves.
Indexing Periodicals, etc.
Blue Printing by Electric Light.

While there are a set of three in stock, they will be sent, postpaid, for 10 cents.

This is fine material for your note book. Order at once. Address,

THE DRAFTSMAN,
Cleveland, Ohio.

To marry for money or to marry without money is a crime.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Tool Drafting.

By S. E. BOYNTON.

LESSON II.

IT may be well to state, that the object of this series of lessons is solely for instruction in tool drafting and not tool making. It would be folly to attempt instruction in tool-making through the medion of a magazine or the correspondence method. Tool-making is a trade and should be learned in the shop, where one becomes familiar with touch and use of tools. Of course those who are now in the shop or tool-room will more readily understand the benefits derived from following this course.

These articles on tool-drafting will not make a first-class tool-draftsman of you, but by following the lessons as they progress and making drawings of the tools specified at end of each article, you will become acquainted with the requirements of a tool-draftsman. You will also acquire some knowledge of modern tools for the manufacture of interchangeable machine parts. This, together with the system and the short-cuts described for drafting, will no doubt be found very profitable.

By carefully studying the accompanying drawings, you will perceive they are a little unlike the ordinary mechanical drawings, with respect to the general rules of drafting. The projections are not *true* projctions, but they are clear and easily read. In tool-drafting use dotted lines sparingly and do not draw a sectional view unless very necessary; it takes up too much time. Do not slight your work in neatness. "Make haste slowly," and this can be done best by working systematically.

Always draw two views of drills, reamers and counterbores, as it shows the shape and number of teeth; though it is only necessary to show teeth in one quarter of the circumference.

Do not shade drawing; it looks very pretty, but gets the dimension lines mixed sometimes. Do not break dimension lines, draw them in full and light.

LESSON NO. 2.

DRILLS.

As drills are such a standard tool in the machine shop and they can be bought so cheaply, there is seldom, if ever, an occasion for making one,—especially the two-lip twist drill. This style of drill is so common and well-known there is no need of our taking it up in our lessons.

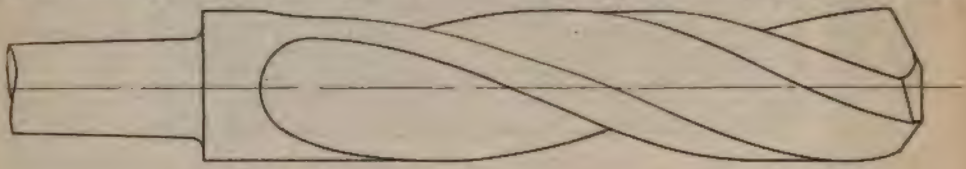


FIG. 1.

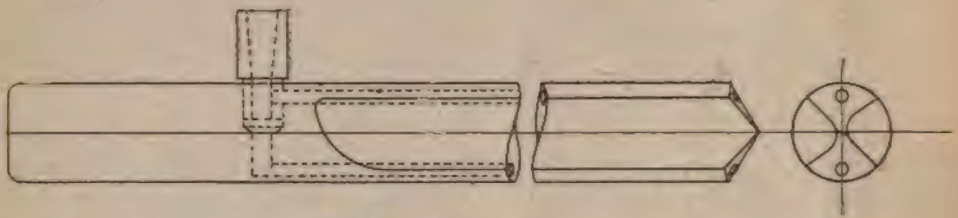


FIG. 2.

The three-lip twist drill is of very similar construction although for almost an entirely different purpose.

This drill is generally made in the larger sizes; from one inch up. It is for reaming cored holes in castings.

Fig. 1 shows a drill of this style. A 3-lip drill is one of the most difficult tools to draw, due to the peculiar form of twist, also in getting the proper projections at the end. Try one. Take the lesson at the last part of this article. The diameter and length of drill can be obtained from a Morse Twist Drill Co.'s catalogue.

The pitch of spiral on drill shown in Fig. 1 is about one turn in twelve inches. This twist is for a drill 1⅞ inches in diameter. The smaller the diameter, the shorter the twist of spiral.

There is no table of spirals of three-lip drills at hand, but a table of spiral pitches is furnished here for two-lip drills. The spiral for three-lip drills differ from two-lip; the pitch of the three-lip drill being longer; the pitch on a four-lip drill being longer still. The angle of twist is approximately 15 degrees for the three-lip drill, and 12 degrees for the four-lip drill.

It may be well to say here that the catalogue plays an important part in drawing drills. A tool draftsman should have a few standard catalogues for reference.

LENGTH OF SPIRAL FOR ONE TURN ON DRILLS, REAMERS AND CUTTERS.

Diameter of Two-Lip Drill.	Length of Twist for one turn in Inches	Diam. of Reamer or Milling Cutters.	Length of Twist for one turn in inches.
1/16	.67	1/4	7.29
1/8	1.12	[illegible]	9.52
3/16	1.67	[illegible]	9.52
1/4	1.94	7/8	13.71
5/16	2.92	1	17.14
3/8	3.24	1 1/4	17.14
7/16	3.89	1 1/2	23.33
1/2	4.17	1 3/4	28.00
9/16	4.86	2	31.50
5/8	5.33	2 1/4	36.00
11/16	6.12	2 1/2	36.00
3/4	6.48	2 3/4	48.00
13/16	7.29	3	48.00
7/8	7.62	3 1/4	48.00
15/16	8.33	3 1/2	60.00
1	8.95	3 3/4	60.00
1 1/8	9.33	4	68.57

In Fig. 2 is shown a straightway drill; it is used for drilling very deep holes in the lathe. The one shown is provided with oil tubes; these are used to supply air or oil to the drill point when in use. Not all straightway drills are provided with oil tubes, but it is good practice to have them. In using these drills, the work revolves (as in a lathe steady-rest) and the drill remains stationary.

There are also twist drills with oil holes.

Although there are many more styles of drills, we will not take them up at present, for fear of the sameness of study becoming too tiresome.

LESSON No. 3.

REAMERS.

A reamer is used for increasing the diameter of a hole to a given size.

After a hole is properly bored, the machine reamer does its work, increasing the hole to within four or five thousandths of an inch of the proper size. A finishing reamer is then run in by hand and reams the hole to the exact size. A reamer revolving in a drill press or any other machine cannot be depended on for accuracy; this is the reason for using a hand finishing reamer.

There are many styles of reamers; in fact, so many, we will not attempt a study of them all, only taking up those most generally used.

A rose reamer is shown in Fig. 3. It is used as a roughing reamer. Another style of rose reamer is shown in Fig. 4. This reamer is identical with Fig. 3 with the exception of its having a detachable arbor or shank. Fig. 4 is called a Rose Shell Reamer. Notice the teeth are practically the same in both reamers, the cutting edges being at the front end. In this respect a finishing reamer differs from a roughing reamer; the finishing reamer does its cutting on the sides of the teeth. Of course the roughing reamer is backed off on the sides to prevent binding, but the most work is done at the end.

Fig. 5 illustrates a shell finishing reamer. It is used as a machine reamer. This reamer differs from Fig. 6 only as regards the spiral of teeth and the method of using. One is used with a hand wrench (see Fig. 6), the other is used on an arbor.

Section of Fig. 5.

Taper reamers are made with the same general construction as Fig. 6. Notice on Fig. 6, although a straight reamer, it has a slight taper for a short distance to allow it to enter a hole.

The table accompanying this lesson will give the proper pitch for spiral reamers like Fig. 5.

Great care should be used in designing a spiral reamer, with regard to the spiral. A spiral is like a screw thread; by revolving in one direction it will draw away and just the reverse if the thread were changed from right to left hand. In

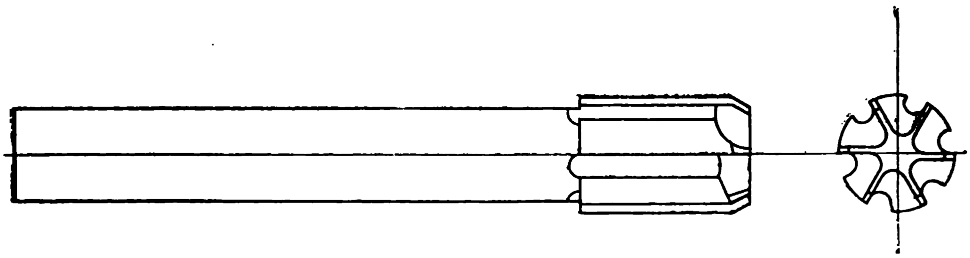


FIG. 3.

drawing a right hand spiral reamer, have a left hand spiral on it. Otherwise it would draw itself into the work and raise mischief. Use the spiral given in table.

It was said at the beginning of this lesson that a machine reamer could not be depended upon for accuracy. We will say in explanation of other things which would seem to contradict this statement, that there are two kinds of accuracy—*commercial* and *exact* accuracy.

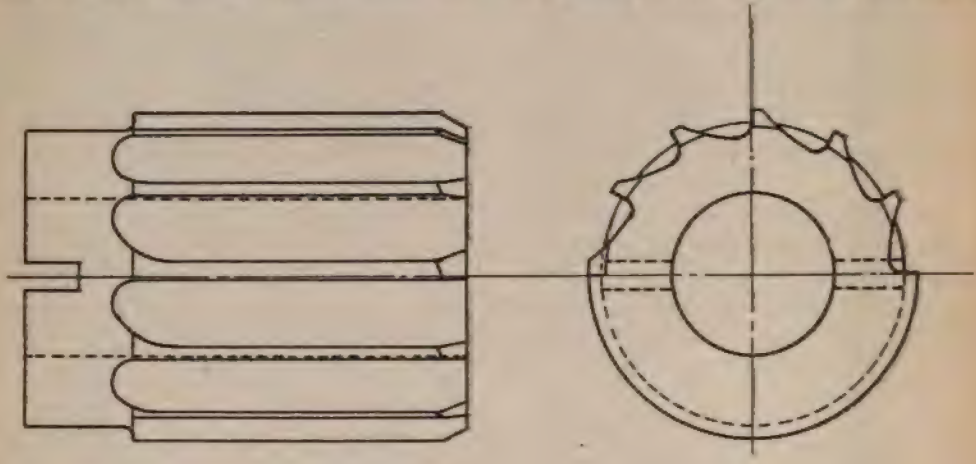


FIG. 4.

A machine spiral reamer will ream a hole to commercial accuracy, which is within .001 of an inch, and is near enough for most commercial purposes. A hand reamer must be used when an exact size is wanted.

Fig. 7 shows a liner reamer, used as shown for reaming two holes in a straight line. This reamer needs little explanation outside of its use, for the dimensions at each end make its construction clear. The small end of reamer is the size of the holes before reaming; the rear end is the finished size like the reamer proper. This reamer is made of tool steel (as all

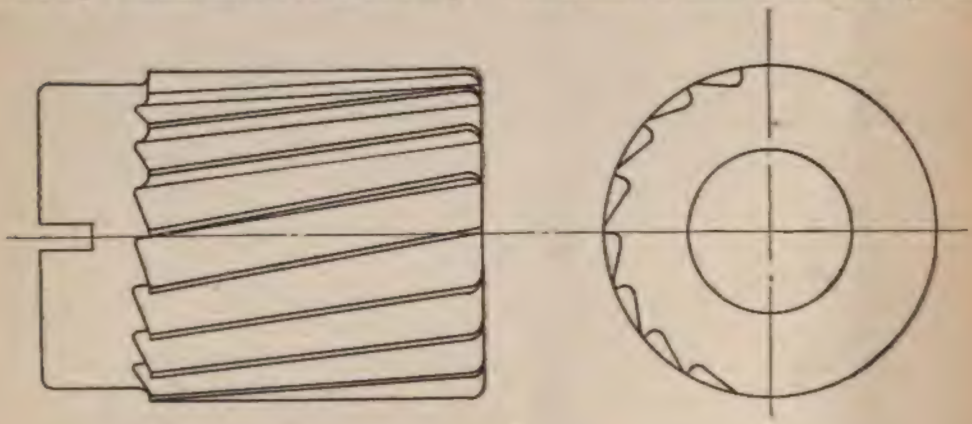


FIG. 5.

reamers are), hardened and ground its full length. These reamers are only used as finishing reamers. There are various methods of making them, but

this is the most universal one. Many times they are made with adjustment to take up wear. These are called expansion reamers.

Under the head of reamers comes a

detachable, and a nnmber of different sized cutters can be used in one shank.

LESSONS FOR PRACTICE.

LESSON NO. 2—DRILLS.

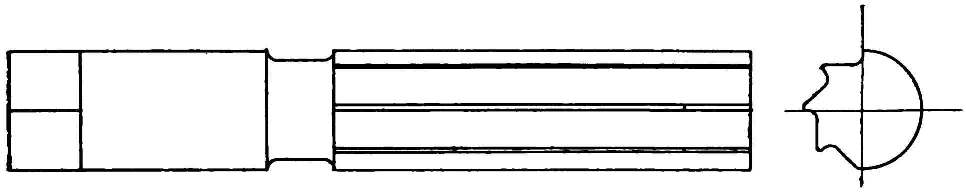


FIG. 6.

tool called a counterbore. The counterbore is made in various ways, but the one shown in Fig. 8 is the most common. The counterbore is used for counter-

(*a*) Three-lip drill $1\frac{7}{8}''$ diameter, with a No. 10 B. & S. taper shank.

(*b*) $\frac{1}{4}'$ diameter straightway drill $12'$ long.

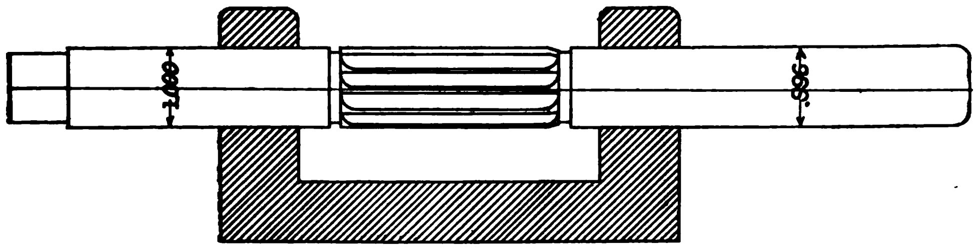


FIG. 7.

boring holes, such as a screw hole, to sink the head of a screw below the surface of a piece of metal. The pilot on the end is for guiding the cutter or

LESSON NO. 3—REAMERS.

(*a*) $3''$ diameter spiral shell reamer.

(*b*) $1''$ diameter liner reamer.

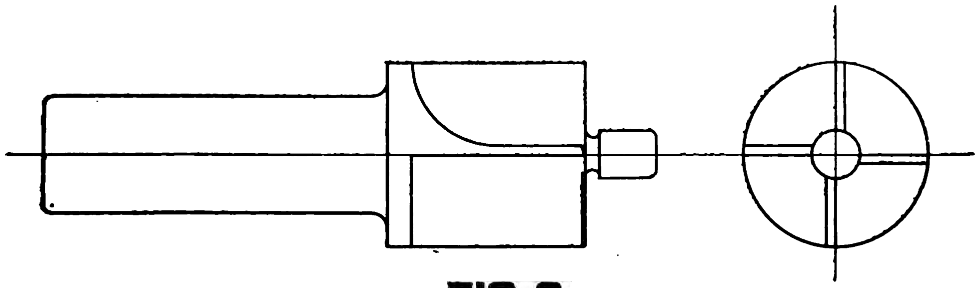


FIG. 8.

reamer and to keep it concentric with the hole. Counterbores are sometimes made with one cutter; the cutter being set in a slot in the shank. These cutters are

(*c*) $\frac{3}{4}''$ diameter counterbore $\frac{3}{8}''$ pilot.

(If you desire to have your drawings criticised, send them to S. E. Boynton, 310 Hancock street, Brooklyn, N. Y, Send return postage.)

STRUCTURAL.

Is Reaming of Structural Steel Advantageous?

The question as to whether or not there is any benefit to be gained by reaming rivet holes in the structural work other than to improve the fit of the rivet in the hole is one on which there seems to be a decided diversion of opinion owing to the different theories held as to injury done by the punch.

The fact that the harder grades of steel, such as Bessemer 60,000 to 70,000 T.S., very often crack when punched has given rise to the theory that the injury done by the punch is in the way of forming minute cracks around the punch hole which expand and split the piece when any great strain is made on it. The benefit of reaming, providing this theory is accepted, is obvious, as it removes the steel immediatly surrounding the hole containing the small cracks. This theory, however, is opposed by a great many on the ground that the annealing of a punched piece seems to show that cracks are not present to a damaging extent except where they extend across the piece. The only remedy in this case, of course, being to throw the piece away and substitute a new one.

The other theory advanced as to the injury done by punching is that the forces the molecules of the steel closer together on the die side of the punched piece. This increases its ultimate strength so that when strain is applied, as soft steel elongates faster than hard, a correspondingly greater strsin is applied on the hard, part immediately surrounding the hole. This will cause it to reach its breaking point before this point is reached in the softer steel. By reaming the hole on the side and thus removing the hardened portion, a uniform breaking strength is gained, so that we may conclude reaming is a benefit if this theory is correct. If the building was properly constructed, nowever, there would be no elongation, as the normal strains would always be well below the elastic limit and the advantage of reaming would only be the protection against an accident which might cause an increase in these strains.

Reaming to improve the fit of rivet in the hole is always done after assembling, and as the greatest damage to the steel is invariably on the die side of the punched piece and as it is often impossible to ream this side after the beam, channel or tee is in place in order to obtain the twofold benefit of improving the fit of the rivet in hole and strengthening same, it will be necessary to ream before and after assembling. This double reaming is now only specified by a few engineers, as a great many claim the annealing of the steel by the hot rivet counteracts the damaging effect of the punch. This is undoubtedly true in a more or less degree, but just how far the effect extends is a question.—*Ryerson's Monthly.*

Proportions in Concrete.

Even though the greatest care is used, certain statements which do not accord with the publisher's views occasionally appear in the journal. It is not always convenient to give an editorial note stating that we do not concur with these views but leave it to our readers to use their own judgment in the matter. Our admonition is to first get hold of the facts, then do your thinking for yourself.

In a contribution last month in regard to a new system of stone making it was proposed to use a face of five parts of cement and one part of inexpensive ingredient for the face. It is the opinion of the writer that even though the cost of the cement were not to be considered such a rich mixture should not be used. It would be liable to the hair cracks and also would not possess the life that a one to one or one to two mixture would. In an admirable article in the same issue a mixture of one part cement, two of sand and two of broken stone was recommended, and the statement made that a common proportion 1:3:5 is too poor mixture to secure the best results.

We have stated a great many times that no definite rule can be given. A 1:3:5 concrete with a certain aggregate may be better than 1:2:3, using a different material. We have also had occasion to state in conversation a great many times that we believe that equally good results can be obtained by using a smaller quantity of cement and a better mix. We have illustrated the poor mixing that is often done, by calling attention to the fact that cement and sand are so nearly the same color that it is thought necessary to shovel it over only three times, whereas with lime mortar the mixing is continued for half an hour or more until the white and dark streaks entirely disappear. Machine mixing is in every way preferable to hand.

Returning to the question of proportions, there has recently been brought to our attention the concrete construction for a large power plant at Plano, Ill., in which the foundations were started with a mixture of one to seven. This was later increased to one to fifteen. After completing the foundations a change of the position of the boilers was made which necessitated the cutting away of a portion of the one to fifteen foundation 8 in. wide by 2 in. deep. The concrete was found to be extremely hard and very difficult to work with a chisel. The same engineer experimented again by putting a 150-horse power engine ten feet up in the air on a foundation one to twenty-five, using a mixture of one to ten for the outside six inches. The material used was good, clear gravel, with the coarser part screened out, leaving the small pebbles a trifle larger than a pea. This was mixed comparatively dry and tamped hard. The same engineer reports that he has several jobs, and he is now using a proportion of cement greater than one to fifteen with exceptionally good results.

We do not wish to be understood as guaranteeing that any person can take one part of cement and fifteen to twenty-five parts of gravel and by poor manipulation produce a superior concrete. The personal equation in the manufacture of Portland cement concrete is a very important one.

The concrete contractor requires a deep foundation and a wide personal experience the same as the manufacturer of steel or wrought iron produces.

Notes on Floor Plan of Small Auditorium.

Width of side isle next to wall, 28".

Width of center isle, 48". Front seat to platform, 7' 0". 20" allowed for each seat and 12" between seats.

ILLUSTRATING.

Rounded Block

ABCDEFGHIJKL
MNOPQRSTUVW
XYZ

ROMAN

ABCDEFGHIJ
KLMNOPQRST
UVWXYZ

ELECTRICAL.

Helpful Knowledge About Electricity.

By EDMUN B. MOORE,
Author of "Wire and Wireless Telegraphy."

PART II.

IN the previous chapter a brief account of the instruments and their use concerning frictional electricity, or as before stated, Static Electricity, is given. We have also seen that when two bodies are charged with opposite kinds of electricity, they are attracted to each other and upon touching one another the negative and positive charges, respectively, are equalized and disappear.

Thus we have seen that an electrified body possesses power to do work, or more commonly speaking, Potential Energy. In the case of the attraction of the two charged bodies a part of the potential energy has been converted into mechanical work, as the bodies were raised toward each other and a part into what is known as Kinetic Energy.

Now, we will place two similar spheres upon an insulated support and charge them as before, but this time connect the two with a wire. Upon bringing the electroscope to these balls we find that the electricity has disappeared, the wire having offered an easy path for the two unlike charges to neutralize themselves. Thus the positive charge has passed along the wire to the negative and regained its equilibrium. It is from the result of this experiment that we so often say, "Electricity flows along the wire." Electricity does not actually flow along a wire or a conductor. This point will, however, be more carefully discussed in succeeding chapters. It is from this so-called flow that we get its name of an electric current.

In the first case of the two suspended spheres the energy was nearly all converted into mechanical work, viz., the attraction of the two bodies. In the second case, no visible mechanical work has been performed, but the electrical energy has been expended in kinetic energy, or in other words, equivalent to the amount used in heating the wire. The kinetic energy in the latter case is exactly equal to the amount of mechanical work done in the first. So we see that by allowing the electricity to flow along a wire the energy of the electrified body is not in the least destroyed, but always reappears in some other form.

Now in our many experiments, we have seen that an electric current will "flow" or pass through a conductor of electricity. You are probably asking yourself the question, Why does this occur? It is perhaps difficult to under-

stand just what exists and what takes place in the passage of the electric current, but nevertheless it is very simple as a theory. It is always characteristic in the passage of the electrical current that it flows from the positive to the negative, that is, from the higher to the lower potential. There must always be a difference of potential to cause this so-called "flow" of electricity.

For an example, we will take two tanks which are connected by a pipe, one being placed higher than the other. If water is poured into the higher tank it will immediately flow to the lower one, and this flow of water will continue until the water has reached its level in the two tanks. Roughly speaking, it is this same process that takes place with the "flow" of the electric current. There being a certain force existing between the positive and negative charges which causes the higher one, or positive, to flow to the lower one, or negative, until an equalization is regained. The force, or difference, existing between the two charges (positive and negative) is called the difference of potential. In measuring the pressure of water and the like, we use an instrument that is known as a pressure gauge which registers the amount in pounds. The corresponding unit of electrical pressure or difference of potential, is called a Volt, named after Volta, a great Italian scientist.

We may condense the above facts and statements and say that if two insulated conductors of electricity at a difference of potential are connected by a wire, or conductor of electricity, a brief electric current will flow from the higher potential, or positive, to the lower potential, or negative, until this pressure is equalized, just as a stream of water flows through a pipe connecting two tanks which are at different levels. It is absolutely necessary in order that a continuous electric current may be produced that a difference of pressure, or potential, be continually supplied in a closed circuit. That is, the conducting path for the electric current must be perfectly complete. If the path is broken from any source, the current will cease to flow and the circuit is said to be open.

We have just explained that it is necessary to have a difference of potential continually that we may have a constant current of electricity, or that it requires a continuous expenditure of energy in one form or another to keep the current flowing.

There are many ways in which this may be done, but the most practical one, and, in fact, the foundation of all other means is by the use of an electric battery or a cell.

A cell consists in its simplest form of two plates of different metals immersed in an acid (or other suitable solution), so that the two plates do not come in contact. The liquid in this case is diluted sulphuric acid, this acting chemically upon the two immersed plates which become positively and negatively charged respectively, with electricity. The metals used in this form of a cell are copper and zinc, the zinc forming the negative, and the copper the positive. These plates are often called the poles or Electrodes of the cell and the liquid in which they are placed is called the Electrolyte.

Upon connecting the two plates with a wire, chemical action at once sets in, and the electric current will flow from the positive plate to the negative plate. The lower end of the positive plate which is immersed in the liquid is negative and the lower end of the negative plate is positive. Upon connecting the two plates with a wire a current not only flows from the positive to the negative plate outside of the cell, but a current

also flows in the liquid from the negative to the positive plate.

The strength and magnitude of the electric current produced from these cells varies greatly with the material used for the plates and the solution used. The difference of potential of these cells, or as it is sometimes called, the Electro Motive Force (E-M-F) of the cell described, wherein sulphuric acid is used, is about .9 of a Volt.

When connecting the two wires of the cell the current will at first be very strong, but will gradually decrease until it ceases altogether. If we now examine the plates closely we will find that a thin film, or bubbles of hydrogen have collected upon the copper plates. This hydrogen gas is caused by the chemical action of the cell. The thin film of hydrogen upon the copper produces a weak electric current within the cell, and of course, this tends to weaken the original output of the cell. It also offers a slight resistance or interferes with the passage of the electric current's strength. This chemical action which has taken place within the cell is called Polarization, and a cell so affected is said to be Polarized.

Many of the types of cells which are now upon the market have this one disadvantage. But if the cell is to be used to any extent the action must be overcome, that is, the cell must be kept depolarized. This may be accomplished by introducing chemicals that will absorb the hydrogen gas. A cell thus remedied is called an open circuit cell, because the depolarization is produced so very slowly that it would be impossible to use it to obtain a steady current. Open circuit cells are generally used for telephone service, ringing bells, signalling, etc., when the required work is intermittent, thus allowing the cell to depolarize while not in active use.

One that is very common in open circuit work is known as Leclanche Cell. In this the liquid is a saturated solution of Ammonium Chloride. The positive plate is composed of a carbon cylinder and the negative of zinc. This cell pro-

Fig. 4—LeClanche Cell.

duces a stronger circuit than most others, the E. M. F. being 1.54 Volts. This type of cell is not intended for anything but open circuit work, but the depolarization is very rapid when not in use, so for intermittent work the current is usually very strong.

The demand at the present time for an open circuit battery that is of suitable size and convenient to handle has led to the development of many types, shapes and sizes. What is known as the Dry Cell has of late been used to a great extent because it is small and comparatively light. Above all it does not contain a liquid as the former cells do.

The negative electrode of this cell consists of a zinc cylinder, the positive electrode, a strip of carbon which is placed in the middle of the cell and occupies about one-half of the space. Instead of using a liquid the electrolyte is in the

form of a paste, consisting of Sal Ammoniac, one part by weight; oxide of zinc, one part by weight; chloride of zinc, one part by weight; plaster of paris, three parts by weight, and water, two parts by weight. This paste is pressed firmly between the carbon and the zinc, in which the chemical action takes place. The oxide of zinc is used in the electrolyte to reduce the polarization; its pres-

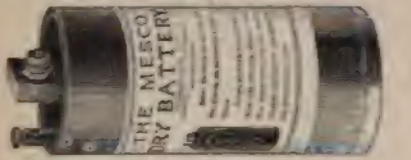


Fig. 5—Dry Cell.

ence also makes the paste porous, and, therefore, allows the accumulating gases to escape. As has been shown, the cell is not absolutely dry, and should not be mistaken for such. The paste contains a fixed amount of moisture, and as this is decreased the value of the cell is somewhat diminished. It is, however, called the dry cell because of its construction, relative to the former types.

We have previously stated that upon connecting the poles of a cell, chemical action at once sets in, and ceases only as the wires are disconnected. This is true to some extent, but within most open circuit cells there is more or less chemical action going on when the cell is not in use. This is caused generally by the impurities in the zinc, which form themselves little local cells upon the zinc, and in due time gradually eat and destroy a part of the value of the zinc plate. This chemical action taking place in a cell in the manner above described, which tends to reduce the original output of the cell, is called local action.

This local action is disastrous to a cell and may be practically overcome by coating the surface of the zinc with mercury. This process is called amalgamating the zinc. The zinc is first cleaned by being dipped into an acid solution and then dipped into the mercury. The mercury covers up the impure places in the zinc, thus leaving the pure metal free. As the zinc is eaten away by the chemical action, the mercury constantly combines with the zinc beneath and in that way the plate is kept in good condition until all eaten up.

In all the open circuit cells previously explained we have seen that zinc has been the metal which has been directly acted upon by the chemicals in the generation of the electric current.

It is not always zinc that is consumed. This, however, varies with the construction and work of the cell. Nevertheless, in any cell where the electric current is produced by the consummation of a given metal, the cells are said to be Primary, or called the Primary cells.

In the advancement of electrical researches and the many numerous experiments, it is often necessary to obtain a constant electric current. Then some other kind of cell must be used in the place of the open circuit cell, as its life when in constant use is very short. Also in order to enable the cell to give a constant current there must not be any polarization whatever, or in other words, the cell must be constantly depolarized. A cell wherein this is accomplished is known as the Edison Lalande Cell, in which the liquid consists of a solution of caustic potash. In this case the positive plates consist of zinc and the negative plates of black oxide of copper. These plates are suspended in the solution from an insulated cover. A zinc plate is placed each side of the copper plate, and the two connected, forming the positive pole.

We will not take the space to describe the chemical action of the cell, but when it is in constant service and the circuit

closed the depolarization is continuous. A heavy oil is poured on top of the liquid, usually paraffin oil, to form a covering about one-quarter of an inch thick. This is to protect the surface of the solution from coming in contact with the air

Fig. 6—Edison Lalande Cell

causing creeping salt which would reduce the life and strength of the battery.

This type of cell is known as Close Circuit Cells, and they must be kept in constant service or the cell will polarize and gradually lose its strength.

Another similar cell which is largely used in closed circuit work, such as telegraph service and the like, is known as the Gravity Cell. The liquid of the cell consists of zinc sulphate much diluted and a strong saturated solution of copper sulphate. The zinc solution being much lighter in weight than the other,

Fig. 7—A Gravity Battery.

will rise to the top. Copper and zinc form the two poles of this cell. The copper is placed in the bottom of the jar and is surrounded by crystals of copper sulphate or blue vitriol. The zinc forms the other pole and is suspended from the top of the jar in the copper solution. When setting up a gravity cell it is customary to short circuit the cell for a few hours, that is, connect the two poles (copper and zinc) by a very short wire. This will hasten the action of the cell and it will be ready for immediate service after about five or six hours of short circuiting. This battery depolarizes very rapidly when not in use and for this reason it must be kept in constant service that you may obtain the best results.

We have previously explained that force of the electric current of the E-M-F is generally expressed in the term Volts. Now the unite of quantity of the electric current is called the Coulomb, after a French scientist living in the 19th century.

In measuring water or gas the unit of quantity is the gallon or a cubic foot (or a gallon of water or a cubic foot of gas). In the electric current, the Coulomb measures the quantity of electricity in just the same relation as does the gallon of water.

If we have an electric current which is carrying one Coulomb of electricity per second, we say that the current of electricity is of one ampere's strength, or a current carrying a Coulomb per second is more often said to be a current of one ampere. This term is also given in honor of a great French scientist whose experiments and scientific investigations are of unlimited value to the world today.

The volt as we have explained is the unit of force, that is, it takes a difference of potential to pass an electric current through any conductor and the volt is the unit of force or E-M-F. It is necessary to have this difference of potential in order to overcome the resistance of the circuit which is offered by the conducting-metal. This resistance or hind-

rance to the flow of an electric current is called electrical resistance. The resistance depends on the composition of the metal, the cross-section of the wire and its length. The unit of resistance is called the Ohm.

Summing up the principal units that are most commonly used in electrical work, we have the following table:

Volt—The electric motive force of the current.

Coulomb—the quantity of the current.

Ampere—the strength of the current.

Ohm—The unit of resistance to the passage of the electric current through conductors.

Fig. 8—Carbon Cell.

When we connect a cell in order to produce an electric current, there is more or less resistance to the wire or in the path of the current. This outside resistance is called external resistance. The resistance offered by the cell, viz., the plates, and liquid, is called the internal resistance of the cell. The external resistance depends upon the kind of metal and varies directly according to the length of the wire and inversely as to the area of its cross reaction. The internal resistance depends upon the size of the plates, the nature of the electrolyte (liquid) and its distance between the plates.

The electromotive force of one cell is very small compared with the amount of current often required to perform various kinds of work. This being the case, and we wish to obtain a stronger current than is given out by one cell, we may combine two or more of the cells. The combination of two or more cells is called an electric battery.

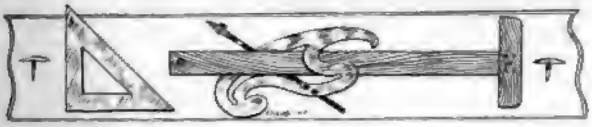
If we have a number of cells, each cell having an output of 1.5 volts and we wish to obtain the combined strength of all the cells we may connect them, as it is called, in a series. That is, the plates of the cells are zinc and carbon respectively, we connect the zinc pole of the first cell to the carbon pole of the second, and in like manner through the entire number. The current may be closed by connecting the carbon of the first cell to the zinc of the last. In this case, if the output of each individual cell is 1.5 volts and the battery consisted of six cells, the total strength of the current obtainable would be six times the output of one cell, or $1.5 \times 6 = 9$ volts. The total number of Amperes obtained in the above battery would be exactly the same as the number contained in each individual cell. If, we will say the Amperage of one cell was 8, the strength of the current would be the same in the battery or in the battery above, nine volts and eight amperes. That is, the strength of the current (in amperes) is not affected by connecting the cells in series.

If, however, we wish to increase the strength of the current (in amperes) we may do so by connecting the cells in a parallel. That is, we connect the carbon of the first cell to the carbon of the second, and so on, and the zinc of the first cell to the zinc of the second throughout the entire number. The circuit may be closed in this case, by connecting the wire from the first carbon plate to a wire running to the first zinc pole. We will suppose that the output of the cell is the same as in the first case, or 1.5 volts and eight amperes each. If the battery is made up of six cells, which are connected in parallel as described above, the

strength of the current (in amperes) will be nearly six times as great and the E. M. F. in volts will remain the same. That is, if the battery of six cells are connected in parallel and the output of each individual cell is 1.5 volts and eight amperes the total current obtained will be 1.5 volts and $8 \times 6 = 48$ amperes, or 1.5 volts and 48 amperes.

Cells are also connected in series parallel in which we have two groups of six cells each. The cells in each group are all connected to each other in series and then these two groups are connected together in parallel. This arrangement is of great value when a stated number of volts and amperes is desired or where any given resistance is to be overcome.

In all the above illustrations and examples we have not taken into consideration the internal resistance of the cells on the external resistance of the circuit. In nearly all cases the resistance will vary greatly but may be practically overcome by the arrangement of the cells as above explained.



DRAFTING ROOM PRACTICE

Portfolio for Drawings.

B. R. WINSLOW.

WHAT to do with the ever-increasing number of drawings and plates that keep piling up on him is a perplexing question to the student, and even the full-fledged draftsman sometimes finds the question staring him in the face.

The student desires to keep his drawing plates, for future reference. In order to properly preserve them they must be kept flat and in a place by themselves. This is not possible except with a portofolio, but these are expensive if bought from the dealer.

The accompanying illustration presents a solution of the problem. By following the directions here given, the amateur can make his own portofolio at a trifling cost.

The body of this portofolio is composed of heavy paste-board, covered with canvas and lined with canton flannel. A pair of scissors and a large needle are the only tools required, as there is no glue used. Glue would cause the paste-board to warp, and it would soak through the cloth, making unsightly splotches.

First cut out the five pieces of paste-board, A, B, C, D, and E, which will require two sheets of what is known as book-binders straw-board. This board should be about $\frac{1}{8}$ inch thick. The curved piece, D, may be struck with any convenient radius. It should, however, be cut two or three inches off center as it will look much better this way than when cut through the center, making a semicircle.

Having cut the boards, spread the canvas on the floor, wrong side up. The canvas or ducking, whichever is used, should be at least forty-two inches wide. Lay out the pieces on the canvas as indicated in the drawing, leaving one and one-half inch space between boards. With the boards in this position take a sharp blue pencil and mark around the pieces close to the edge, going entirely around each piece. Now make another line one-half inch from the first, this time going around the outside edges of the pieces only. This is the cutting line, and the one-half inch space is to allow for seams. Having cut out the canvas cover, the canton flannel is next spread on the floor and the canvas laid on this as a pattern.

Canton flannel does not come wider than 36 inches, so it will be necessary to piece it a trifle by sewing a piece on each side, to make the flaps C and D. The lining can now be cut by following the

canvas pattern.

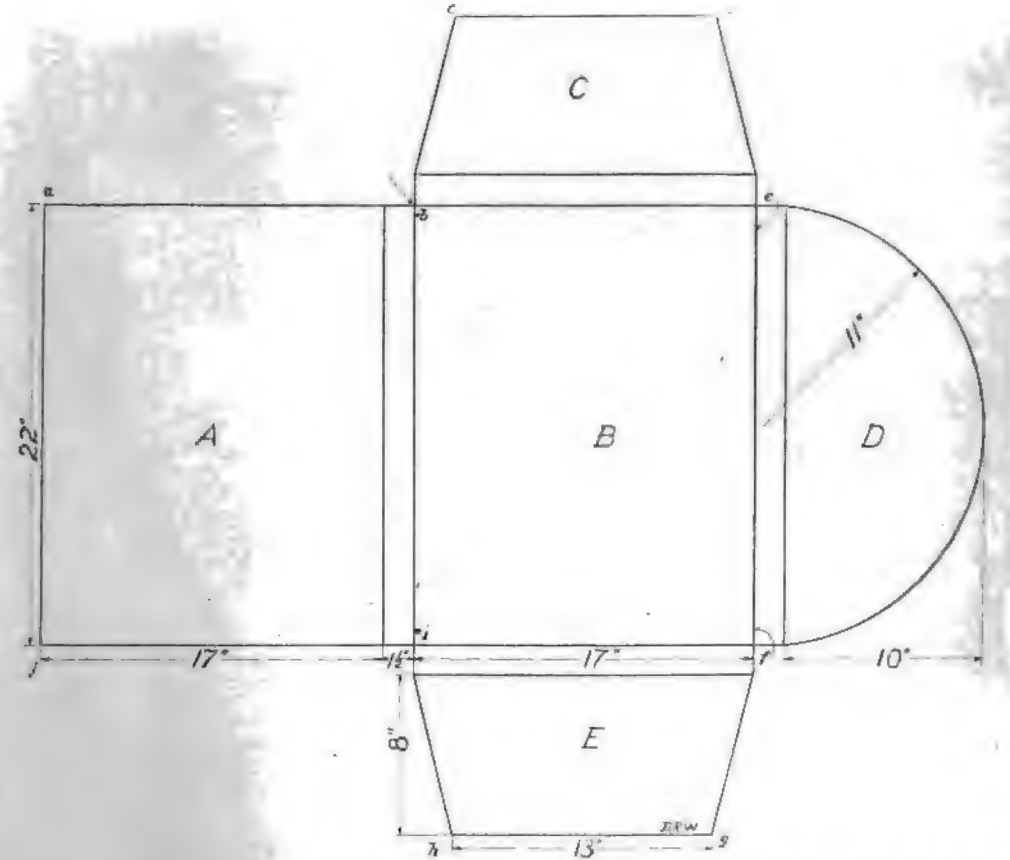
Before beginning to sew the pieces together, cut slits in the four corners, b, e, f and i as indicated at b. This is to provide for the corners.

Now sew the pieces together face to face, that is, the right or fuzzy side of the canton flannel against the right side of the canvas. Begin sewing at a and go all around the outside, stopping at j, following the blue pencil marks on the canvas.

Next put in the flap pieces C and E and sew them in in the same manner.

Before inserting the piece B, run a row of stitches one and one-half inch from the bottom of piece D along the line e f. Then insert the piece B, pushing it well up against this row of stitches. Sew this in place with a row of stitches along the outer edge b, i, and also along the two short edges b, e and f, i.

After running a row of stitches one and one-half inch from b i, insert the



Turn the bag thus formed through the opening a, j. The pasteboard body is

D. Push this
a needle and
and canton
raight edge
pping out.

piece A and close up the opening a j by lapping the canton flannel over the edge of A and tucking the canvas down behind it, sewing the two edges tightly together.

The drawings are placed on B, and the two flaps C and E are folded over them. The large flap A is next folded over and

finally the flap D. An elastic band, made of one inch elastic, will serve to hold the portfolio closed, or any suitable clasp may be attached.

Brown for the cover and white for the lining are good colors to use, but if preferred both cover and lining may be dyed black before the boards are put in.

Letter on Drafting Room Practice.

EDITOR DRAFTSMAN.

Dear Sir,—It may be of interest to some of your many readers to know how the drawings of a small elevator and general pneumatic work company handle their drawings so that the pattern and machine dimensions are never confused.

When a part is detailed on manilla paper it is drawn to finished dimensions, and after approval is traced. Blue copies from this tracing go to the shop for the machinists. The drawing is then touched up with red ink, dotted lines showing the allowance for finish to be made by the pattern maker, unless there is to be an equal amount of finish on all the spots to be machined, when the symbol "f" in red ink is placed on the spots and a note made that "f" equals so much. All dimensions that differ from the machine dimensions are placed on the drawing in red ink, the machine dimensions in pencil being allowed to remain.

This drawing is then sent to the pattern maker, who tacks it on a board and leaves it there while working from it. The drawings have always been returned in good condition. They are then filed away, and as they are indexed as soon as they are drawn, it is an easy matter to find them again when wanted.

By this method if a pattern is lost or destroyed the pattern maker works from the same drawing that the original pattern was made from. Any changes that are necessary are noted on the original drawing in black ink unless the changes are too sweeping, when it is deemed best to make a new drawing.

I have used this system for about two years, and although the patterns are made by an independent firm, and some have been very intricate, have had no trouble by the machine and pattern dimensions being confused.

Yours very truly,

39 Baker St.,
Winsted, Conn.

R. H. LIBBEY,
Draftsman with
Geo. Miles Co.

Daily Time Card. **Engineering Department.**

THE WELLMAN-SEAVER-MORGAN ENGINEERING CO.

Name ———————— Timekeeper's Check ————————

Date ————————

Contract No.	Proposal No.	Drawing No.	Hours

Approved ———————— Total time, - ————

A Drafting Room Time Card.

HOME STUDY.

Hydrostatics.

C. C. MASON.

WE all know, more or less, that hydrostatics is that science in mechanics which treats of liquids at rest.

A perfect liquid is a substance the molecules of which are free to move upon one another without friction and without mutual attraction, and therefore they may be made to change their form with the slightest force. Many liquids fulfil these conditions enough for practical purposes, but not perfectly. They are very nearly incompressible, and even when put under great pressure the change in volume is minute. Judging from the fact that a pressure exerted at the rate of 15 lbs. to the square inch on water that its volume is decreased but fifty millionths, or 1-20,000th part of its volume. This liquid, however, is of greatest importance in the use of hydraulic machinery. Looking further in the subject, we find that Pascal's law says that pressure exerted anywhere upon a mass of liquid is transmitted undiminished in all directions, and acts with the same force upon all equal surfaces and in a direction at right angles to these surfaces. Therefore, a pressure exerted on any surface is proportional to its area. This is shown as in Fig. 1. The vessel is filled with water and its outlets closed by means of pistons, A B C D E, whose areas are 1, 2, 3, 6, 8 inches, respectively. If A has a pressure of one pound, the pressure exerted on the under side of piston B will be 2 pounds, on C 3 pounds, on D 6, and on E 8 pounds. As such an arrangement cannot create energy when the piston A moves down 1 foot, B will move 6 inches, etc., etc. This proves conclusively that by the illustration as shown that one pound at A can support 5 pounds at E, and therefore by increasing the ratio between the areas of these pistons, A and E, a small weight will be able to raise a larger. Under these principles the hydraulic jack and press are constructed. Figure 2 is a sectional area of a hydrostatic press.

A bale of cotton or some object to be pressed is placed on and between the large piston head P′, and the stationary plate G. On raising the handle or lever of the pump a vacuum is created in the chamber E. The valve, N, closes and the difference in pressure in the chamber W and the reservoir causes the water to open the valve V′ and thereby flow into the chamber. While on bringing the lever down L, the valve V′ closes, and the pressure is transmitted through the tube T to the chamber. The pressures therefore exerted are equal to the areas of the two pistons, and in consequence of which as this inequality may be very great, a corresponding increase

of power is obtained. Thus: What is the pressure at P′ if a force of 85 pounds is exerted at the end of a lever 5 feet long; the distance from the fulcrum of the pump being 8 inches, and the pistons P′ and P, having their diameters 1 inch and 12 inches?

Solution: P × Power Arm = W × W Arm.

$$85 \times 60 = W \times 8$$

$$W = 637.5 \text{ lbs. pressure.}$$

We therefore see that a force of 85 pounds applied to a lever bring about a pressure of 637.5 pounds on the piston. The areas are to one another as the squares of their diameters, or P=637.5× 144 pounds, and allowing 10 per cent of this for friction, which must be taken into account.

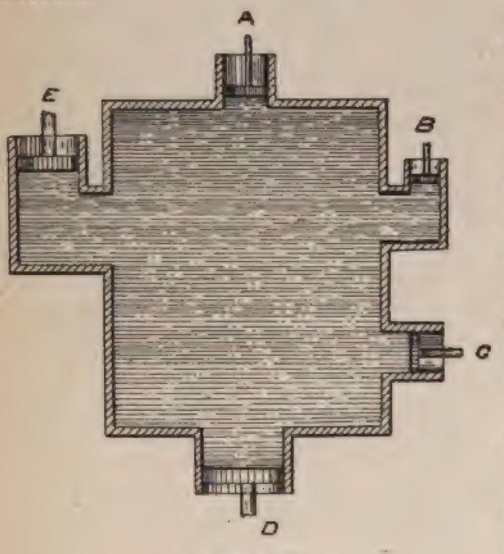


FIG. 1

Liquid in a vessel exerts pressure against its walls, and this pressure may be lateral, upward or downward, but all are resolved under these three components. We imagine two vessels of unequal capacity filled with water, for argument's sake, but each of which having the same area of base and depth, the water will exert the same pressure on their bases, and referring again to Pascal's law, we find pressure is transmitted in all directions equally. The pressure of a liquid upon the bottom of a vessel depends entirely on the density of the

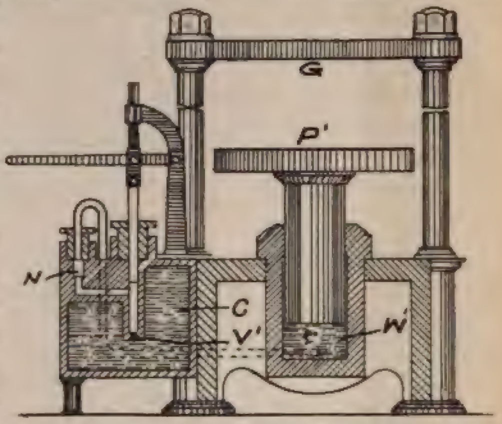


FIG. 2.

liquid, area of the bottom, and is solely independent of the quantity or shape of the vessel.

This rule is applied in finding the downward pressure on a horizontal surface. Find the weight of a column of water whose base is equal to the given surface, and whose height is equal to the depth of the given surface below the surface of the liquid.

Therefore, we find that the pressure on the bottom of a vessel filled with water whose depth is 3 feet and 2 feet diameter is 1.3 pounds. Thus—

The vessel contains $3 \times .7854 \times 2^2 = 9.42$ cubic feet. Weight of 1 cubic foot water =62 1-2 pounds, therefore the total weight is 62.5×9.42 pounds, and the area=$.7854d^2$ or d=diameter

$7824 \times 24 \times 24 = 452.39$ sv. in., and the pressure per inch =

$$\frac{588.75}{452.39} = 1.3 \text{ pounds.}$$

A liquid is said to be equilibrium when its surface is horizontal. If a liquid is contained in several vessels communicatingly, the surface of the liquid must be in the same horizontal plane in order

to bring about equilibrium. We know positively that water will not run up hill, and we speak of water finding its level. Well, we will illustrate an Artesian well. The tendency of water to rise to its level in several tubes having arms from a well. The pressure beneath the surface of the earth on the water coming from a higher land causes it to rise many feet above the surface of the boring. Another proof of water finding its level may be applied to the spirit level and several forms of nature prove this inevitable and everlasting fact.

C. Charles Mason.

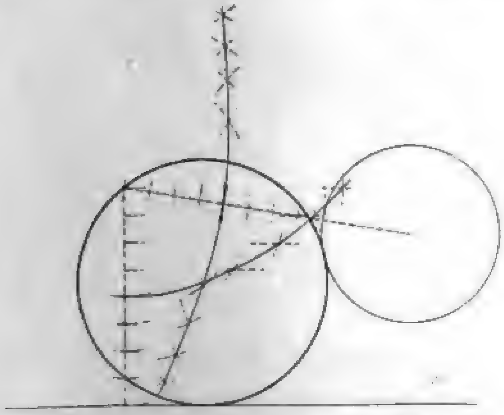
Solutions of Line, Circle and Point Problem.

Cleveland, O., Sept. 8, 1905.

The Draftsman.

Dear Sir—I enclose my solution of the Problem of Line, Circle and Point.

Solution.—Locate the curve which is the locus of all points equidistant from the given point and the circumference of the given circle; also locate the curve



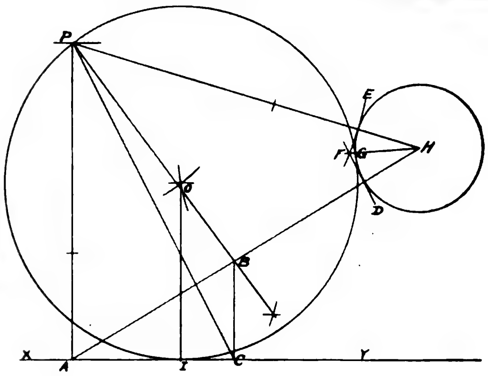
which is the locus of all points equidis- ... and the given ... hese curves is ... circle whose ... his point to

Respectfully submitted,
Charles H. Thompson.
361 Cedar avenue, Cleveland, O.

The Draftsman.

Gentlemen—I notice in my August issue of the problem, To scribe a circle cutting through P and tangent to line XY and to the circle H. I believe I have got what you want, it is as follows:

Scribe a circle H of any radius, and the point P at any distance from H, and then draw the line XY at any distance from H or P. Now draw a vertical line to XY, cutting P, then connect A with H and P with H, which would give the triangle, P-H-A, bisect angle P cutting A-H at B. Then at B draw a vertical line to XY intersecting XY at C, then connect C with P. Then draw line D parallel with PC and tangent to circle H. Then with P as a center and the radius PH minus the radius of circle H which would be tangent to circle H, draw an arc E where D and E intersect at F, connect F with H, then the line F and H crosses the circle H at G, taking G as a center and any convenient radius scribe



an arc, and with P as a center and the same radius scribe another arc, through the intersection, draw a vertical line cutting line XY at I, with I as a center and the same radius as before, scribe another arc; keep on adjusting compasses till the arcs intersect, which when taken as a

center and radius equal to OP and scribe a circle would cut through P and come tangent to the line XY and the circle H, which is what I think you want. By this solution, you can place either point at any distance from each other.

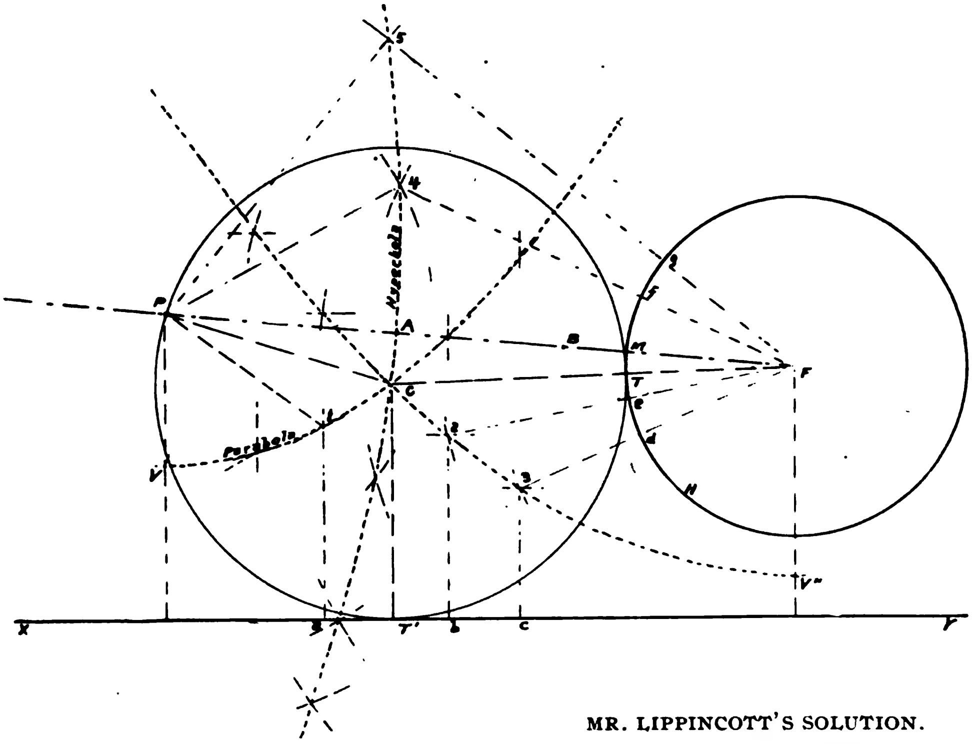
If I am correct, place the same in your next issue of The Draftsman.

To oblige,

E. F. Ulrich.

Adrian, Mich.

Given point P, circle H, and line XY. To find the center of circle passing through P and tangent to H and to XY.



Construct a parabola (V-C) with P as a focus and XY as a directrix; all points on this curve will be equidistant from the point and line, therefore, it will contain the required center.

Construct an hyperbola (A-C) with P and F (center of circle H) as foci and A (half way between P and circle H) and B (FB=AP) as vertices; all points on this curve will be equidistant from the point and the circle and it will therefore contain the required center—with the intersection of these curves C as a center and the distance CP as a radius describe the required circle.

A third curve (V''-C) having its points equidistant from the line and circle may be constructed as a check.

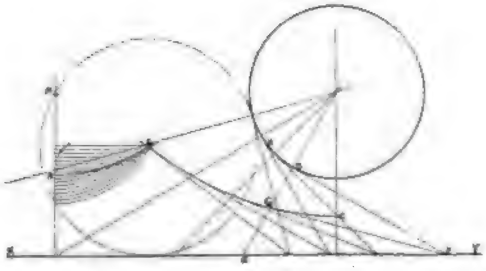
A few construction points are shown on diagram:

a1=1P, b2=23, f4=4P, T'C=CP, C3=3d, g5=5p.

J. McHenry.

MR. LIPPINCOTT'S SOLUTION.

AB is the locus of points equidistant



from P and XY.

BC is the locus of points equidistant from H and XY.

B is equidistant from P H and XY, and is the center of the required arc.

DF is tangent to the circle at D.

GF is the bisector of the angle DFE.

Respectfully,

F. A. Lippincott.

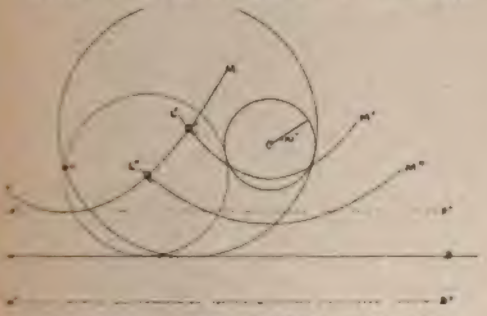
86 Portland street, Cleveland, O.

Problem.—To find a circle which shall pass through a given point and be tangent to a given circle and to a given straight line.

Construction.—Let P be the point, C the center of the circle, and AB the straight line. Denote the radius of the given circle by r. Draw A′ B′ and A″ B″ parallel to A B and distant r from it.

With C as focus and A′ B′ as directrix construct the parabola L′ M′.

With C as focus and A″ B″ as directrix, construct the parabola L″ M″.



With P as focus and A B as directrix, construct the parabola L M, meeting the parabolas L′ M′ and L″ M″ in Q′ and Q respectively. Then Q′ is the center of a circle internally tangent to the given circle and fulfilling the other given conditions, while Q is the center of a circle externally tangent to the given circle and fulfilling the given conditions.

Proof.—(Given only for the point Q, the proof for Q′ being similar).

By definition of a parabola, the point Q on the parabola L″ M″ is equidistant from C and A″ B″. Since A″ B″ is distant by construction from A B by the radius of the circle, Q is equidistant from A B and the circumference of the circle. Since Q is on the parabola L M it is equidistant from P and A B.

Q is equidistant from the point P, the circle C, and the line A B.

Discussion.—The solution giving the internally tangent circle with center at Q′ vanishes if C approach nearer to A B than the distance r.

There will be no real solution whatever if C lie on the opposite side of A B from P, and is distant from A B by a distance greater than r.

The points Q and Q′ also lie on a hyperbola, of which P and C are the foci, and r the difference between the focal radii.

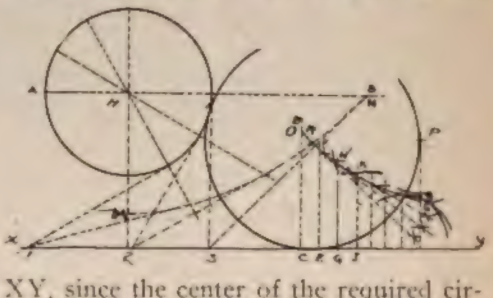
Donald M. Liddell.

Baltimore Copper Smelting & Rolling Co., Baltimore, Md.

Editor The Draftsman.

Herewith please find my attempt at the solution of the problem, To draw a circle tangent to circle H and to line XY, also passing through point P.

In the first place the center of the required circle will evidently be at the intersection of the locus of the centers of circles tangent to circle H and line XY, with the locus of centers of circles passing through point P and tangent to line XY, since the center of the required circle must be in each of these lines.



By dividing circle H into any number of equal parts and drawing tangent as shown intersecting XY or XY produced

as in points 1. 2. 3. then bisecting the angles between these tangents and XY thus formed, the center of any circle tangent to H and XY can be found at the intersection of these bisectors and the radii drawn to the point of contact of the tangent. By obtaining, in this way, a sufficient number of centers (which number has been purposely made too small in the figure in order to avoid complication) curve M N can be plotted. This curve is then the locus of the centers of circles tangent to both H and XY.

By erecting perpendiculars C D, E F, etc., to XY at any points C, E, G, etc., the centers of circles tangent to XY and passing through P, will be found at the intersection of these perpendiculars with the perpendicular bisectors of the chords drawn from the point P to the points of tangency of the circles which, of course, will be the foot of the perpendicular. Then R S is plotted from these intersections, hence R S is the locus of centers of circles tangent to XY and passing through P. The intersection of this line with M N which is shown at O' is then the center of the circle tangent to H and XY, and passing through P.

The proof of the various steps is so easily seen that I am loth to trespass upon your valuable space to give it, feeling that I have already encroached too much in giving so much space to a description which is so cumbersome that someone is certain to evolve a more desirable and more accurate one. Let me thank you in advance for the consideration which I know your courtesy will cause you to give this, my humble effort.

Yours,

Leon C. Daniels.

New London, Conn., Sept. 13, 1905.

CURRENT TOPICS.

Of pens and pencils there is a quite
A lot that can be said;
To drive a pen may be all right,
But pencils must be lead.
—From Dixon's "Graphite."

A Modern Course.

"What course will he take in college?"

"I don't know, but I think it's glee club and football."

STRANGE to say, the August and September issues of THE DRAFTTMAN have been entirely exhausted. There are more subscribers on our list than there were the 1st of July, and it is growing nicely.

WE ARE preparing to aid our readers to secure some reductions in subscriptions to other papers. Send in a list of the ones you want, and let us quote you a price on the set, including THE DRAFTSMAN.

A NEW department has been established in THE DRAFTSMAN, entitled "Drafting Room Practice. Under this head will be found reviews of articles in other journals and new matter pertaining to the drafting office. Some matter formerly found under "Current Topics" will be allotted to the new heading.

MANY replies have been received in answer to the request to draw a circle tangent to another circle, a straight line and through a point. The solutions will be found under "Home study."

Industrial and Personals.

Messrs. Fording and Henry, formerly with the Garrett-Cromwell Eng. Co., have opened offices in the Rose Bldg., Cleveland, O.

Messers. Fraser and Fox, for some time with the engineering force of the Brown Hoisting & Conveying Machinery Co., have joined Mr. J. C. Spencer in the Rockefeller Bldg.

Mr. Wm. Von Wolfrot, former chief draftsman of the Interstate Enginaering Co., Bedford, O., is now situated in the Superior Bldg. in business for himself.

Mr. Chas. H. Pierce, draftsman with the L. S. & M. S. Ry. at Cleveland, has deen appointed instructor in theoretical and applied mechanics at the University of Illinois.

Mr. A. L. Westcott, who has been in engineering work in the city, will be in the engineering department of Case School of Applied Science this year.

The American Shovel and Stamping Co., of Lorain, O., will build a sheet mill to make their own material. They have been looking for an engineer to take charge of the work.

About two years ago a prominent engineer of wide experience decided to start in business for himself. A suite of rooms were fitted up, but nothing came in but

dull times and the collector. Not despairing, he gave up the fine offices and moved to his home, and is now doing a big business. Ability will be recognized, even if the office is in the attic.

Mr. R. H. Libby, draftsman with the Geo. Miles Co., Winsted, Conn., has accepted a good position in Newark, N.J.

A fire on Michigan street, Cleveland, recently burned the quarters of several manufacturing plants. The Browning Engineering Co. had an electrical and engineering department in the building. They have acquired control of five acres of land and a shop building adjoining their plant in Collinwood, O. This shop will be used by the electrical and engineering departments. The Root Incubator Co. will occupy a portion of the building also.

The Toledo-Massillon Bridge Co. will run forty draftsmen in their new plant against fifteen in the old. The Vulcan Iron Works will also increase their number when they move from the river front to a new plant across Dorr street from the new Toledo-Massillon plant.

On Organizing a Society.

In our September issue we suggested a Constitution and By-laws for a society of draftsmen, and since that time have had some very nice letters on the subject.

One gentleman gave his views by writing out a complete Constitution and By-laws far better than the one we proposed, but lack of space in this issue prevented printing it. If our readers so desire we shall be glad to do so in our next issue.

EDITOR DRAFTSMAN.

Dear Sir.—Please allow me a small space in your valuable columns to say a few words regarding the possibility of a draftsmen's union. To commence with, it would be a safeguard to employer and employe. Another thing, while I do not propose strikes, etc., yet I think in many cases it would prove beneficial where draftsmen are ill used and could have protection from such a union or association. If not, why not? There are men who are working for a mere pittance, men who have spent years of hard study and toil in securing their knowledge of a particular line, and who on account of unjust salary have to remain at this standard with little or no hopes of rising further. I hold that such a protection is necessary, Mr. Editor, and it is degrading not only to the draftsman, but to the engineering world universally. Just think, a nincompoop cobbler making a better livelihood than a technical graduate! Of course, I don't forget there are men of little account in every case, and therefore allowances must be made for this class also, but speaking as a whole of the better class of men, in several instances working nine and a half to ten hours per day for $75 per month. It is far better if young men gave up technical study if such a state of affairs is allowed to continue.

Thanking you for your space, I am,

Yours truly,

VOX POPULI.

EDITOR DRAFTSMAN.

Dear Sir.—For a while now a man can get most any kind of a promise out of a lot of shops if he says he is experienced and will go to work. There are plenty of dimensions for him who has been "through the mill," but "turn-downs" for the fellow with the nice picture under his arm, who hasn't any idea that a drafting room is a "wilderness of figures" instead of a picture gallery.

You haven't heard from a lot of us, financially or otherwise, I think because everyone has his hands so full there is no time for you, the *News*, the *Record* or the *American Machinist*.

It seems that interior plants who don't get a good show when orders are scarce against lake port, river landing and Pittsburg district shops, are having a hard time getting men. For as we get old we learn that boards in certain places are going when the chief even of the inland office is looking for work. So brother don't go somewhere now when any place can get orders, because later on the dollar or two extra now will not last very long. Don't you think you should give your readers some such warning as the above?

Referring to the Rivet Signs you gave a while ago as the American Bridge Co.'s standard, can say they are "Pencoyd" and obsolete. Railroad engineers would not accept them. so the ones in the Carnegie Hand-Book are the standard.

Did you ever stop to consider that our trade has not been "labor-saved" a single stroke (regardless of what may be argued) since man took a sharp stick and scratched his plans in the sand?

Yours respectfully,

H. C. T;

The architects, engineers and draftsmen of Fort Worth and Dallas, Texas, have organized the Southwestern Technical Society with the view of extending it further. The time is ripe for such an organization of this kind in the Southwest and it is felt that it is a good step towards the advancement of these professions. The officers are: Charles D. Hill, President; B. Gage Leake, Vice-President; Frederick E. Henkel, Secretary and Treasurer, Fort Worth.

What Is Art?

This question was asked the other day for a short definition. Books have been written on the caption of these three words. Count Tolstoi has a volume to expatiate on the short answer: "Art is the transfer of feeling," with which Paul Bartlett, the sculptor, seems to agree. The art critic, W. C. Brownell, holds that the emotions of men have not much to do with their art expression, while George Moore declares that the intellect must take a leading part.

The best definition I have ever seen is by Delsarte:

"Art is feeling passed through thought and fixed in form.

There is the formula that fits every case, the test that is infallible. The feeling may range from the simplest sensuous sense of form and color to towering agony or mad exaltation; the thoughts may vary from the craftsman's tradition-made practical considerations to the philosophy of a Goethe, but fix the results in form and you have art. The proportions may, must differ by the width of worlds in different arts. Music is in a sense rightfully called the purest of the arts; here you have intense emotion without either the expression of articulate thought or the use of imitation. But the root of the matter remains just the same in a Miltonic sonnet or an Israel's "Madonna of the Cottage." The emotion is what lifts the thoughts into the power of expression.

That is Art—who knows a better definition?

We wish to call attention to announcement of an Elementary Course in Mechanical Drawing which is now in book form. This course appeared in THE DRAFTSMAN, and having been carefully revised, is arranged in two parts and bound in cloth in a flexible style so they will lay flat on the table when open. Part I contains 64 pages, 6x9, and matter for 13 plates. Part II has 32 pages, 6x9, with matter for eight plates, three tracings and a title page. There are some notes on blue printing in Part II. Price of each part bound in cloth 50 cents.

A Course in Tinting has been issued, giving matter for finishing five plates in

color. The color plates are all shown complete, and the description is quite clear for the outline of the plates and preparing the wash. Price bound in paper, 30c. Address THE DRAFTSMAN.

Civil Service Examinations.

The U. S. Civil Service Commission announces examinations for the following positions: October 25, 1905, farrier, at San Juan, P. R., at $840 per annum, and another vacancy at $720 per annum and ration, at Washington, D. C.; laboratory assistant qualified in electrical measurements, $900 per annum; laboratory assistant, qualified in weights and measures, $900 per annum, both in the Bureau of Standards; marine fireman, $540 per annum, at Seattle, Wash.; teacher of agriculture at $1,000 per annum, in the Chilocco School, Oklahoma.

Write to the Editor.

Every editor desires to make his paper a clearing house for the ideas as well as for the news of the day.

It is a joke as old as daily newspapers that when an Englishman is in trouble he writes about it to the London *Times*. He does, and this national habit has contributed more than anything else toward making the *Times* powerful.

Letters from readers are always welcome, whether the writer be indignant, pleased, sore, in trouble, or so happy he feels the editor ought to know it. Long letters, or short letters, sarcastic or sympathetic, in prose or verse, written in blood, ink or charcoal,—all are cheerfully received, eagerly perused and impartially considered.

In a sense every issue of this newspaper is a letter from those who make it to those who read it. It is made up of news, articles, editorials, business and other announcements. Some of these interest you; some do not. But when you are interested,—a whole lot interested,—the newspaper letter to you becomes personal and calls for a reply. The editor sends you his views and information every week-day in the year. The only way to balance things up is, once in a while, to answer back.

Yes, write to the editor.—*Cleveland Press*.

Fire from Sunlight.

A newspaper item says that a house in Saybrook, Conn., was believed to have been fired by the rays of sunlight focussed on a window curtain by a gold-fish globe and speaks of the matter as "curious." It certainly is that, but we believe that fires resulting from such causes are by no means rare. Some two or three years ago, says the *American Architect*, the writer's son while at the dinner table at Mern, in the Tyrol, called his pupil's attention to the way in which sunlight was being focussed on the table-cloth by a full water carafe, and suggested that enough heat was being generated to be dangerous. The lad's father, a university professor, opposed the idea, and as they argued they saw the spot on the table-cloth darken, and then flash into flame, which was handily extinguished by the water that had helped convert tne carafe into a perfect lens. There are many authenticated cases of fires being caused by the old-fashioned bulls-eyes, once generally used for doorheads and side lights, and the bubbles in crown and cathedral glass have proved to be equally dangerous. Large bubbles in glass used in the skylights over unfinished attics, places often used for the hanging of women's light dresses, should be carefully avoided, and for the same reason the skylights in hay barns should be inspected. Probably more than one hay-barn, whose destruction was attributed to fermentation and spontaneous combustion, was caused by a bubble in the glass.

Some time ago we published an account of the application of the idea of the Archimedean screw to a pleasure device. The inventor of this apparatus is Mr. John J. Carr, of 282 Van Brunt street, Brooklyn, N. X., who has organized a comqany to put the device on the market.

Machine Shop Philosophy.

By Joe Cone.

A watched pot never boils, but a workman frequently does.

There's no trouble about the man at the bench finding the best side of the file.

When things begin to look prosperous around the office you may look for a cut-down.

The young machinist should pay more attention to the chips on his lathe than those on the street.

Some men work harder working their employers than they do working for their emyloyers.

No machinist is willing to admit he's a has-been, and nine times out of ten he isn't.

Book Reviews

Technic of Mechanical Drafting,

Second edition, 42 pages well illustrated and eleven full page plates, by Mr Chas. W. Reinhardt, Chief Draftsman of the Engineering News. Pages 7½" by 11", well printed and bound in loards. Published by the Engineering News Pub.Co, New York, N.Y.

While this work was not designed primarily for the beginner there is a vast amount in it that will be of use to such a person for the writer has endeavored to give a thoroughly practical common-sense guide to good mechanical drafting.

It stands alone among books in its characteristic and represents modern drafting more nearly than anything on the market.

This edition of the book has been improved by the addition of a new chapter on "Lettering" and also some matter on "Topographical Drafting."

The latter gives a complete outline for that study and the tabulated topographical conventions together with the corrected standards of section-lining will be useful to the draftsman, who is willing to improve hinself.

"Excuse me," began the slouchy looking man to the one who was in a hurry, "but did you ever stop to think—"

"No, I never did; I don't have to; I think just as well when I am in motion. Good-day sir."

New Inventions.

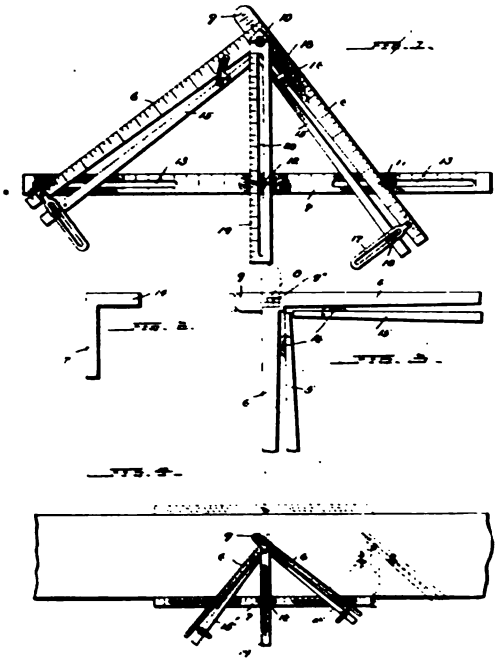
The following inventions have been specially reported for The Draftsman by C. LeRoy Parker, solicitor of patents, 707 G street, Washington, D. C.

SQUARE.

No. 796,030, Charles J. Baumgartner, August 1, 1905.

The square is formed of two arms (6) in the usual manner. At the corner the arms are recessed on the under side to receive the tongue (8) of a nosing (9), which may be of any desired size. The nosing may be reversed by loosening the thumb screw (10) by which it is held in place, and may be adjusted in or out by means of the slot (*9a*) through which the thumb screw extends.

A cross bar or straight edge is indicated at 7, extending between the arms of the square. This cross bar is not permanently attached to the arms, but may



be clamped thereto by thumb screws (11 and 12), the former extending through one of the slots (13) in the ends of the bar. The bar is preferadly angular in shape, giving a broad flange (14) to rest on the stringer in the stairwork.

15 represents blades which are attached to the repective arms of the square, at inner edges thereof, by means of slotted links (16 and 17), which permit the blades (15) to be adjusted at any desired angle, within bounds, to the arms (6) to suit the different width and inclinations of the threads or risers which are to be used in the work. Thumb screws (18) fasten the parts at adjustment.

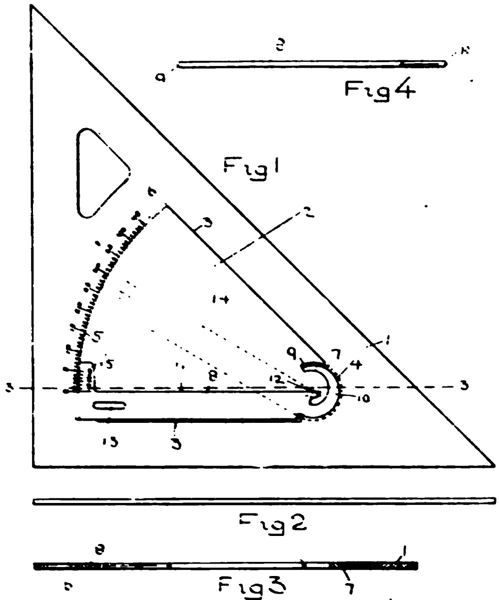
A center guide or blade is indicated at 19, secured to the cross bar (7) by the thumb screw (12), which extends through a slot (20) in said blade, and by the thumb screw (10) at the corner of the square. This guide or blade is useful in centering circles, squares or angles in determining other measurements.

PROTRACTOR.

No. 796,417. Axel Edwin Enberg. August 8, 1905.

The object of this invention is to provide a protractor capable of being combined with other drawing instruments, such as a triangle.

Held within the opening (2) is a protractor bar (8), having its opposite ends provided with V-shaped edges (9 9), adapted to fit the V-shaped grooves (6 7). One end of the protractor bar is curved to fit the curved arc (5), and the opposite



end is provided with a tailpiece (10) curved to fit the circular recess (4). The tailpiece (10) is bent in semicircular form and is slightly elastic, so that when the bar (8) is crowded into position, the tailpiece (10) will exert a slight pressure in the direction of the length of the bar, so as to hold the V-shaped edges of the bar in close engagement with the V-shaped grooves in the edges of the triangle, and in order to accomplish this result the combined length of the bar (8) and tailpiece (10) is slightly more than

the distance between the edges of the arc (5) and the circular recess (4), so that the tailpiece (10) is slightly compressed when the bar is placed in position, so that the pressure of the tailpiece (10) against the abutting edge of the triangle will serve to hold the bar in position and also to produce sufficient friction between the ends of the bar and the edges of the triangle to enable the bar to be held in any of its adjusted positions within the opening 2. The edge (11) of the bar is drawn on a radial line of the curved arc (5), and extends a short distance past the center (12) of the circle of which the line 5 is an arc.

FOLDING SQUARE.

No. 797,120, Arve Johnson, August 15, 1905.

This invention relates to folding squares, particularly to the provision of a joint between the two arms of the square, together with efficient means for holding said arms in adjusted position.

The arm 6 is recessed as at 15, and at one end one of the walls of the recess tapers, as at 16. The rear end of the extension 12 is shaped to correspond to the outline of the recess at this end, being beveled as at 17, which part registers with the tapering portion 16 of the recess when the square is open. The recess forms a seat for a key 18, which is also tapered as at 19, to correspond to the parts 16 and 17, and is arranged to be slid behind the extension 12. The key being wedge shaped, it can be tightly jammed against the extension, theredy securely holding the arm 7 in adjusted position. The key is retained in the recess by being dovetailed thereinto. Upon sliding the key from behind the extension the square can be folded, as illustrated.

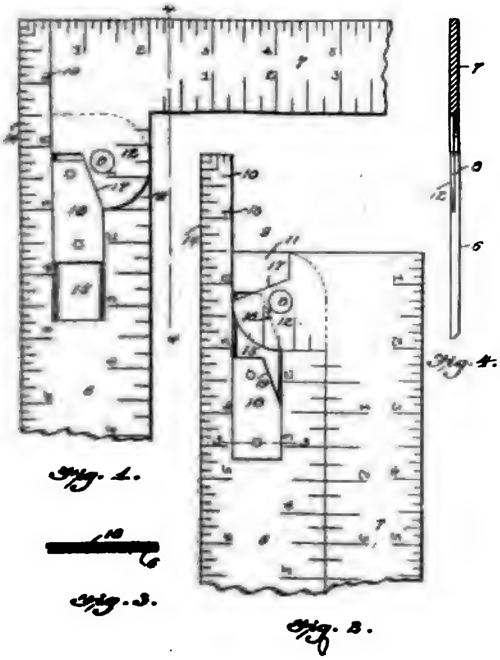


Fig. 1. Fig. 3. Fig. 2. Fig. 4.

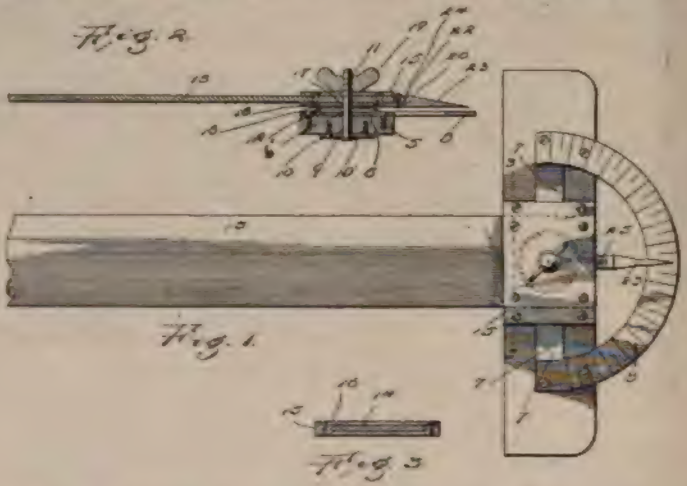
T-SQUARE.

No. 797,228, James Arthur Robinson, August 15, 1905.

This invention relates to T-squares, and more particularly to adjustable T-squares, and has for its object to provide a device of this nature which will be so arranged that it may be set to any angle, and which will be provided with a scale in order that the degree of the angle may be exactly determined.

The blade 13 of the T-square has one of its ends disposed in recess 14 in a plate 15, the upper face of the blade lying flush with the face of the plate, and secured against the blade and the plate in another plate (16), the plates (15 and 16) and the blade having aligning perforations (17) therethrough, in which is revolubly engaged the bolt 11. Projecting outwardly from the plate 15 beyond the rearward edge of the head 5 is a lug (20) having a threaded perforation (21) therein, and the outer end of this lug is received in a recess (22) in the under face and at the end of a finger (23), having a passage (24) aligning with the perforation 21 for the reception of a screw

25 to hold the finger to the lug. The outer end of the lug is beveled, and the recess 22 is similarly beveled. The finger 23 projects over the segment 8 to indicate the scale thereon, which, as illustrated, extends through ninety degrees of a circle, and when in use when it is desired



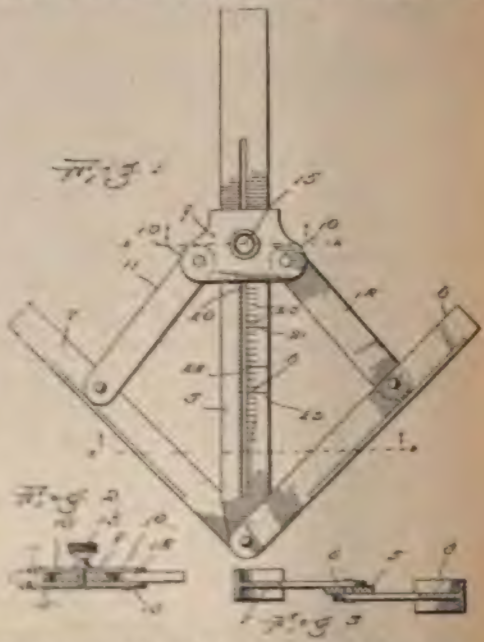
to draw a line at a certain angle the wingnut 19 is loosened and the blade is moved with respect to the head until the finger indicates the desired angle, after which the wingnut is tightened and the line may be drawn in the usual manner.

SQUARE.

No. 797,453, Henry W. Nagel, August 15, 1905.

It is the purpose of this invention to provide a drafting instrument which may be adjusted for use as an ordinary square or as a bevel.

The plate 5 is marked on the upper face near the slot 6 with a scale from which the sleeve (9) travels, the sleeve with the scale indicating the angle at which the arms 7 and 8 lie. It will be noted that the scale comprises four long markings, 20, 21, 22 and 23, which indicate respectively where to set the sleeve in order that the arms may lie at an angle corresponding to two sides of a square, a pentagon, a hexagon and an octagon respectively. The member 5 always bisects the angle between the arms. The long marks referred to are at one side of the slot. Between the long marks referred to are shorter marks (25), which in connection with the long marks form a pitch scale and show the pitch of the bevel, that is, they indicate the rise in inches to the foot. It will of course be understood that one scale may



be on one side of the plate and the other scale on the other side.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Tool Drafting.

By S. E. BOYNTON.

LESSON III.

IN this lesson we will study the different forms of screw thread-cutting tools, such as taps, dies, hobs and chasers. Although this subject would seem of a simple character, you may be assured that it covers a broad field, and comprises some very complicated tools. It will, however, be necessary for us to deal with the subject in a brief manner, because of its length and the limited space at our disposal.

A tool draftsman seldom has occasion to draw the ordinary commercial tap or die; but there are times when it is necessary to draw special tools of this kind, such as a tap for some particular job, where the shank is longer than usual, or is made to fit some special machine.

There was a time when manufacturers made mongrel sizes of taps to suit their special screws, this being done for business reasons, so as to compel their patrons to obtain their special screws to fit their machines. This, however, is no longer the case; now, nearly all concerns work to a given standard, as they find it cheaper to buy standard taps than to make them special.

It would be an imposition on the intelligence and patience of the reader to enter into a description of the various forms of screw threads, for the majority who read this article are familiar with them. But to recall to your memory in a general way the existing forms will, no doubt, be of advantage. The accompanying diagrams will make it easy for you to distinguish them.

A tap is quite similar in construction to an ordinary machine screw, with the exception of the head, or shank, which is generally squared to fit a wrench, or flattened for a screw, depending on circumstances.

Fig. 1, shows a tap in the process of manufacture. Notice its similarity to a machine screw. Then look at Fig. 2 and see this same tap completed. You

will observe that the first would not tap a hole for the reason that it has no teeth. If, however, four grooves were cut lengthwise of the tap, so as to leave sections of the the thread standing, it would readily

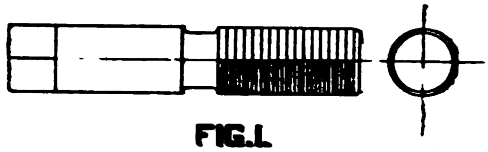


FIG. 1.

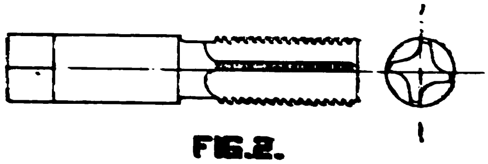


FIG. 2.

do so. In this case the standing sections would act as teeth, and the grooves as chip clearances. This is the principle of all taps, large or small. Taps are made

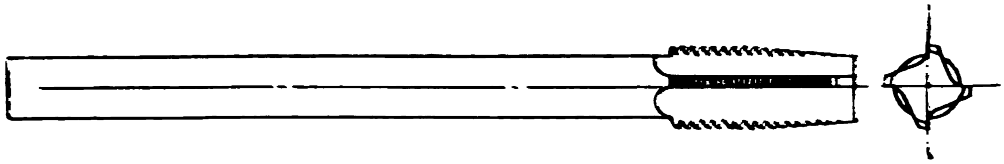


FIG. 3.

of a high grade of tool steel, and carefully tempered, for they sometimes have considerable work to do.

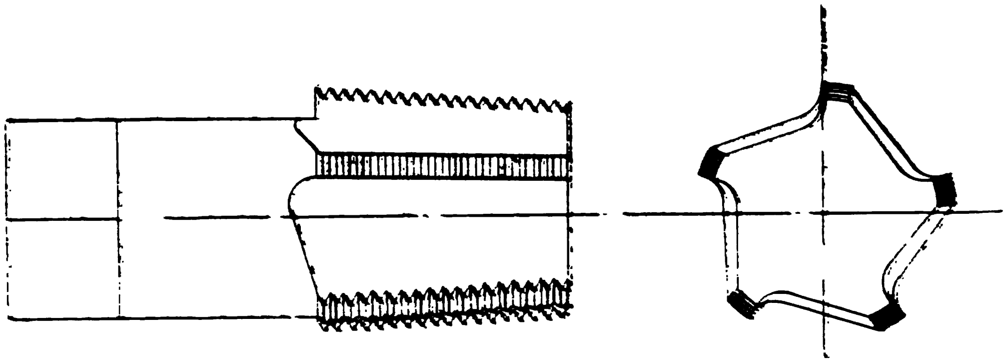


FIG. 4.

Fig. [illegible] shows the ordinary *hand tap*, the construction being the same for *machine taps* with the exception of the shank which is made to suit existing conditions. Taps up to one inch in diameter are usually provided with four grooves; when the pitch is very fine there are more, so as to distribute the work on the teeth.

Fig. 3 shows a nut tap, so called because it is especially adapted to tapping nuts. When in use it is kept in constant motion, the nuts to be tapped being held so as to permit them to pass over the thread onto the shank (which is smaller than the hole in the nut). This is continued until the shank has been filled with nuts, when the machine is stopped and the nuts removed.

A pulley tap differs from a nut tap only as regards the shank, which is sometimes very long, due to the large diameter of the pulleys to be tapped. The shank is squared at the end for a wrench.

Fig. 4 shows a pipe tap. All pipe taps have a taper of three-quarters of an inch to the foot. Tables of pipe threads are published in a number of catalogues, and will no doubt be found in previous numbers of THE DRAFTSMAN. However, there is seldom occasion for drawing a

tap of this description.

Fig. 5 shows an adjustable die which is of the most common form, and, though a commercial article, is very often made in the shop. The adjustable die is used in either a machine or hand die holder. Notice the construction: The three recessed points are used for holding and adjusting in connection with the small

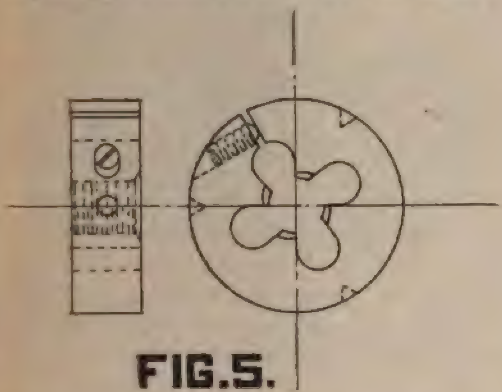


FIG.5.

screw in the slot. You will also observe that the die, which is almost cut in half, is held together only by a small section. This is done, as you will readily see, to obtain adjustment.

By looking into almost any machine tool catalogue you will find a number of patent adjustable dies, but very few are used in actual practice. We are to deal here only with those in general use.

Fig. 6 shows a solid die. Solid dies have no adjustment, but are made to some standard size. The outside or body of the die can be made to conform to any die-holder; they are sometimes made round, as in Fig. 5.

There is no fixed rule for the thickness of dies, but in common practice the thickness should not be less than the diameter of the thread. Sizes over one inch in diameter are all about the same thickness, about seven-eighths of an inch.

Fig. 7 shows a machine chasing tool, and the means of holning it. A chaser does practically the same work as a die, but it is necessary for it to be fed along while cutting. It is generally used in a lathe where the feed can be geared up to conform with the pitch of thread. In

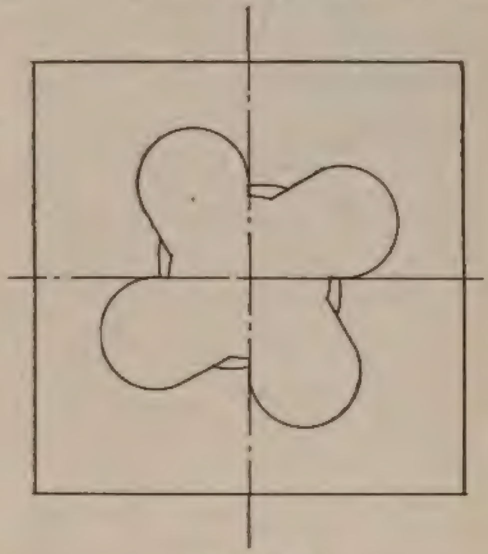


FIG.6.

this respect it differs from a die, which feeds itself along automatically.

Another tool which is often classed with the chaser is the hob. A hob is nothing more than a tap, but has a few more teeth, and is made more accurately. The chief difference between the uses of the chaser and the hob is that the chaser is used to cut master taps, and the hob to cut master-dies.

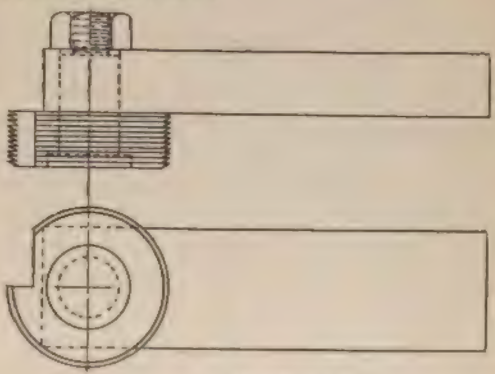


FIG.7.

We have now covered our subject in a way that will convey an idea of the general construction of thread-cutting tools.

We are, however, far from being proficient in the drafting of thread tools until we are acquainted with some of the modern methods.

The most up-to-date way of cutting screw threads is to mill them. Some prominent concerns are now manufacturing special machines for this purpose. Although almost any thread can be milled, the milled threads are confined to the larger sizes; in most cases only threads for feed screws and conveying purposes are milled; threads like the U. S. Standard, or Powell (see diagram), are used for feed screws.

Another method of making screw threads is to roll them on a surface instead of cutting. Fig. 8 shows a diagram of this method. One die remains stationary, while the other has a reciprocating motion; only one stroke is necessary to complete a screw. This method is only adapted to small screws, because of their not being accurate enough over $\frac{3}{4}$ inch diameter, though screws under this size are sufficiently good for most commercial purposes. The principal advantage of this method is the cheapness of manufacturing. About twice as many screws can be turned out by this method as by any other. As the study of thread-rolling dies is quite complicated, and as such study would necessitate the introduction of an additional number of diagrams and illustrations, we will have to continue with things more essential to our present purpose.

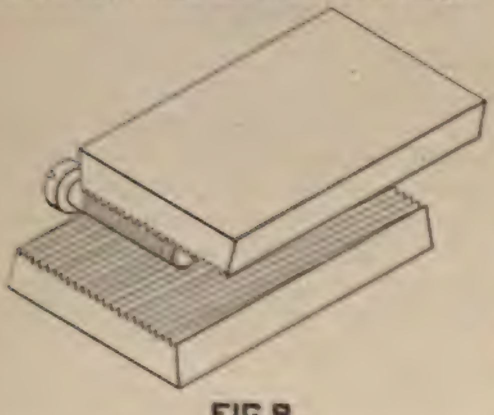
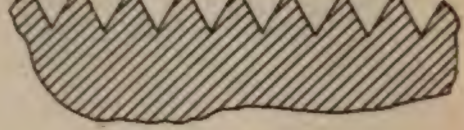


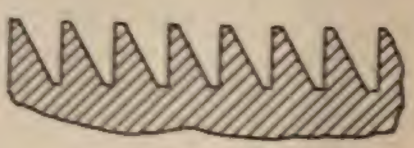
FIG. 8.

Powell.

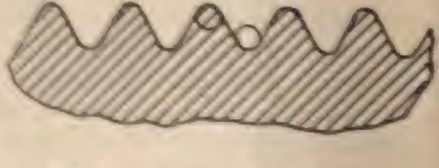


"V" Thread.

U. S. Standard.



Trapezoidal.



Whitworth.

Do not forget to draw up some of the following tools for practice:

(*a*) A one-inch hand-tap "V" thread.

(*b*) A one-half inch nut tap.

(*c*) A three-quarter inch adjustable die.

(*d*) A one inch solid die, square outside.

310 Hancock St., Brooklyn, N. Y.
Sept. 21, 1905.

Strength of Sections of Machinery.

BY FRANK B. KLEINHANS.

In order to determine the strength of any part of a machine which acts as a beam, we must first determine the maximum bending moment for any given section and then determine the maximum fiber stress produced by this moment. By the ordinary method, this is a long and tedious job, and requires considerable time and patience. Once the results are obtained, they are cast aside and are of no use for future reference. To overcome this difficulty, the accompanying table has been prepared, which gives the moment in inch-pounds for various fiber stresses for circular sections. At the extreme left hand side of the table the diameter of the section is given in inches. Along the top are given various fiber stresses varying from 2,000 to 12,000 pounds per square inch.

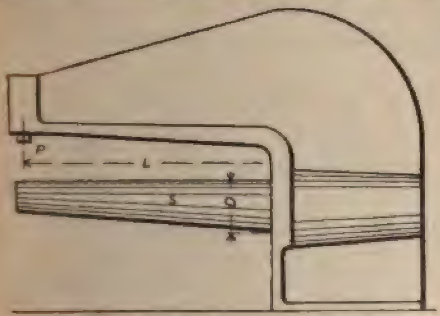


Fig. 1.—Sketch of Stake Punch and Riveter.

In order to more fully explain the use of the table, several examples will be given. Fig. 1 shows a stake punch and riveter. The stake S is a steel forging of circular section. The load P = 30,000 pounds; L = the distance from the support to the load, = 50 inches; M = bending moment, = 30,000 × 50 = 1,500,000 inch-pounds.

For a steel forging, the working stress should be taken at about 12,000 pounds per square inch. Referring to the table under column headed 12,000, we find the nearest moment to be 1,568,000, which is a little more than the required bending moment. The diameter of the section which corresponds to this bending moment is 11 inches. The diameter of the stake at D would, therefore, be made 11 inches. In like manner the diameter of any other section can be determined from its distance from the load P.

Fig. 2 shows another case where this table can be used to advantage. B is the cross beam for a hydraulic draw back plunger; P is the force exerted on the plunger. Let L = the distance between pressure points or length of beam, = 40 inches; P = $7\frac{1}{2}$ tons, = 15,000 pounds.

Then M, the maximum bending moment on the head beam =

$$\frac{P \times L}{4} = \frac{15{,}000 \times 40}{4} = 150{,}000 \text{ inch-lbs.}$$

This plunger and beam would be made of cast iron, and therefore a working stress of 3,000 pounds should be used.

Referring to the table, under column headed 3,000 we find 151,000 as the nearest bending moment, which corresponds to a solid section 8 inches in diameter. A round section would not be used for such a beam for a number of reasons, but an I beam section would be used instead.

Fig. 3 shows the method for obtaining the size of the I beam section. We strike an 8-inch circle as shown, and then draw

an I beam section over the circle, letting the top and bottom flanges project beyond the circle, by an amount that will equal in resisting power the material cut away from the sides. This is a matter of trial, the solution being correct when the sectional area of the material cut away times distance A equals the area of

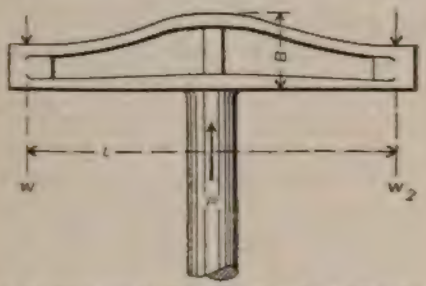


Fig. 2—Hydraulic Plunger Head and Platform.

the upper flange times B plus that of the lower flange times C. This can be done more accurately than one would suppose, and with a little practice one is able to get a satisfactory result in a comparatively short time.

Fig. 4 shows the method of obtaining the section for the steel housing for a large hydraulic riveting machine. Let P = 150 tons, the pressure on the dies, = 300,000 pounds; L = 17 ft. 6 inches, the distance from the riveter die to the section, = 210 inches; M = maximum bending moment. — P × L. = 300,000 × 210 = 63,000,000 inch-pounds.

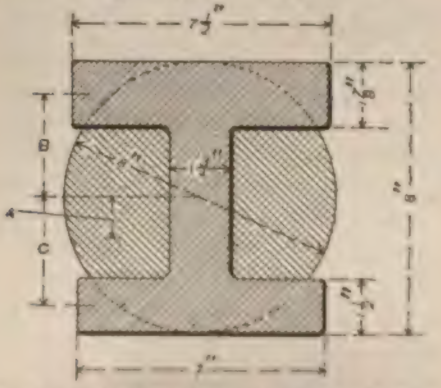


Fig. 3.—Method of Determining the I Beam Section to a given Circular Section.

The housing would be made of cast steel, the working stress of which in tension would be about 8,000 pounds per square inch. Referring to the table

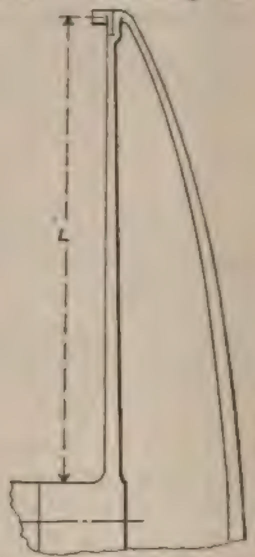


Fig. 4.—Housing of a Large Hydraulic Riveter.

under column headed 8,000 pounds we find the nearest bending moment to be 66,800,000 pounds, corresponding to a 44-inch solid circular section.

Referring to Fig. 5, strike a circle 44 inches in diameter. This casting is circular on the outside; otherwise it is like

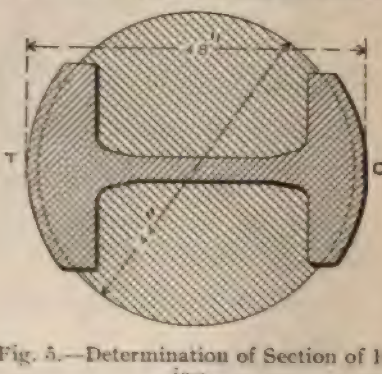


Fig. 5.—Determination of Section of Housing.

an I beam section. We sketch out a section on top of this circle, making the portion which extends beyond the circle equal in resisting value to that which is cut away from the sides as explained for

Fig. 3. The tension side of the casting I is made heavier than the compression side C in the proportion of 10 to 9. In a similar manner, a number of other sections can be determined and finally the shape of the casting will be found like the curved line in Fig. 4.

MOMENTS IN INCH-POUNDS FOR VARIOUS FIBER STRESSES.

Dia	2,000	2,500	3,000	4,000	6,000	8,000	10,000	12,000
1	196	245	295	392	590	780	980	1,180
1½	660	828	990	1,320	1,980	2,640	3,380	3,960
2	1,570	1,960	2,400	3,100	4,700	6,280	7,850	9,420
3	5,280	6,620	7,900	10,600	15,810	21,120	26,600	31,700
4	12,560	15,700	19,000	25,200	37,800	50,240	62,800	75,600
5	24,500	30,680	36,700	49,000	73,500	98,000	122,500	147,000
6	42,400	53,000	64,600	85,000	127,200	169,600	212,000	254,400
7	68,000	84,200	101,000	135,000	202,200	269,600	337,000	404,400
8	100,500	125,700	15 ,000	201,000	303,000	404,000	502,600	603,000
9	143,100	179,000	215,000	286,000	429,000	572,000	716,000	859,000
10	196,400	245,500	294,000	392,000	588,000	784,000	982,000	1,178,000
11	261,300	326,700	392,000	522,000	783,000	1,044,000	1,307,000	1,568,000
12	339,300	424,400	509,000	678,000	1,017,000	1,356,000	1,696,000	2,036,000
13	421,000	526,200	632,000	842,000	1,263,000	1,684,000	2,155,000	2,526,000
14	538,800	673,500	809,000	1,078,000	1,617,000	2,156,000	2,694,000	3,234,000
15	661,000	826,000	992,000	1,322,000	1,983,000	2,644,000	3,305,000	3,966,000
16	804,000	1,005,000	1,210,000	1,608,000	2,412,000	3,216,000	4,020,000	4,824,000
17	963,000	1,204,000	1,440,000	1,926,000	2,889,000	3,852,000	4,815,000	5,778,000
18	1,145,000	1,431,000	1,720,000	2,290,000	3,450,000	4,500,000	5,725,000	6,900,000
19	1,344,000	1,680,000	2,010,000	2,688,000	4,020,000	5,360,000	6,720,000	8,060,000
20	1,571,000	1,964,000	2,350,000	3,142,000	4,710,000	6,280,000	7,855,000	9,420,000
22	2,090,000	2,612,000	3,140,000	4,180,000	6,270,000	8,360,000	10,450,000	12,540,000
24	2,710,000	3,387,000	4,070,000	5,420,000	8,130,000	10,840,000	13,550,000	16,260,000
26	3,368,000	4,210,000	5,060,000	6,730,000	10,110,000	13,480, 00	16,840,000	20,220,000
28	4,310,000	5,390,000	6,470,000	8,620,000	12,930,000	17,240,000	21,550,000	25,860,000
30	5,292,000	6,615,000	7,940,000	10,584,000	15,870,000	21,160,000	26,460,000	31,740,000
32	6,432,000	8,042,000	9,650,000	12,864,000	19,290,000	25,720,000	32,160,000	38,590,000
34	7,704,000	9,630,000	11,600,000	15,408,000	23,100,000	30,800,000	38,520,000	46,200,000
36	9,160,000	11,450,000	13,740,000	18,320,000	27,480,000	36,640,000	45,800,000	54,960,000
40	12,568,000	15,710,000	18,900,000	25,136,000	37,800,000	50,280,000	68,810,000	75,600,000
44	16,720,000	20,900,000	25,500,000	33,440,000	50,100,000	66,800,000	83,600,000	100,300,000
48	21,680,000	27,100,000	32,500,000	43,360,000	65,110,000	86,800,000	108,400,000	130,200,000
52	26,960,000	33,700,000	40,500,000	53,920,000	81,000,000	108,000,000	134,800,000	162,000,000
60	42,320,000	52,920,000	63,000,000	84,000,000	126,000,000	168,000,000	211,600,000	253,800,000

DRAFTING ROOM PRACTICE

Hints to Draftsmen.

C. C. MASON.

YEARS ago an education, speaking from the real standpoint, was looked upon as being entirely unnecessary and superfluous. But conditions have made a vast change along with the times, until the profession of the mechanical, structural and architectural draftsman has become an interesting and profitable one.

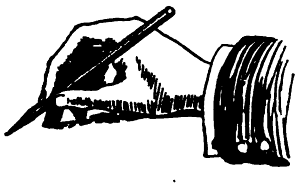
This is the age in which the best man gets the best position. In order for these men to attain good paying positions, they must devote hard study and practice to become experts in their would-be calling. The "reward of application" is certain. The draftsman or student who desires a complete knowledge of everything that pertains to their work, and are willing through practice and perseverance to labor to this end, will find good positions waiting for them, and will surpass the men who only desire a superficial knowledge of the work before them. To these I will give a few practical hints in brief.

Calling one evening at the Central Institute (Willson avenue), I heard a student say, "I cannot make good lines because my hands are heavy and hard from working in a machine shop." This is a mistake. All that is necessary is practice. The weight of the pen alone is sufficient. The pride of the draftsman is his drawing pen, also called the high line, and sometimes ruling pen. Of all instruments this is most frequently used, and should be of superior quality. The back blade should be stiff, so as not to spring if pressed a little hard against the square. The points or "nibs" should be precisely the same length, and rounded in the direction of their breadth, so that they present but little more than a point. If too sharp it will produce a ragged line, caused by the pen cutting into the paper, and if not sharp enough, will bring about lines that vary in thickness or diameter, using a technical term. Considerable practice and patience, however, are required to get the knack of shaping a pen just right.

The pleasing appearance of a drawing depends largely upon the arrangement of the different figures. The appearance, as a whole, should be symmetrical. This is secured by a proper placing of the figures with respect to each other, as well as perspective. It is often difficult to estimate the space which any one

figure will occupy when drawn, or rather, what the general effect will be when compared with other adjacents or background. No general rule can be given, but the attention is called to this point. Figures or objects should never appear to be placed, but occupy their positions naturally and easily. Some draftsmen while tracing try to improve their penciling, but it is common experience that the accuracy of the drawing is seldom improved upon in the rendering of it. In pen and ink work it is well to learn to draw with a pen, *i. e.*, to make lines as free and easy with the pen as with a pencil.

There is but one way to do anything, and that's the right way, and know how. We every day see people holding their pens and pencils between the first and second fingers, but if they knew how much more rapidly they could draw or write, they would change for the better. The following figure shows the correct and only right way of holding a pencil. The pencil should be held at right angles to the line to be drawn when drawing straight lines, and at an angle of about 30° to the paper, while in order to insure



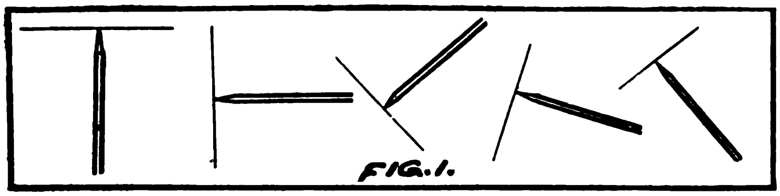
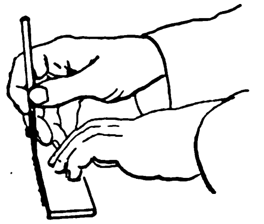
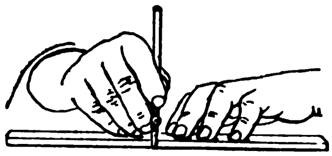


FIG. 1.

good smooth lines, the ruling pen or right line should be held perpendicular to the right line. By so doing you not only obtain true smooth lines, but the pen keeps longer in good working condition, as both points or nibs wear evenly, in consequence of which the trouble of sharpening, &c., are lessened. The importance of freedom of movement cannot be over-estimated. It produces lightness of touch, quickness in execution, and begets confidence in one's ability to draw. Too much stress cannot be laid on the necessity for freedom of move-





ment. The ability to sketch and draw easily and rapidly a thought awakened in the mind cannot be attained without it. The more rapid a draftsman can sketch, the better able is he to go out and make a rough sketch of any broken machinery or architectural detail. Practice becomes perfect, and upon that only can any draftsman depend to succeed.

The progress by which the hand becomes skilled in performing work, and the eye trained to equalize space, measure distances and proportion objects, is necessarily slow, and to those who lack application it is quite tedious.

The draftsman very often has to square or multiply a mixed number (a whole

number and a fraction), whose fraction is $\frac{1}{2}$, and it is well to know that this can be done mentally as follows:

Add 1 to one number, multiply by the other, and add $\frac{1}{4}$ to your answer. Take $3\frac{1}{2} \times 3\frac{1}{2}$. $3+1=4$. $4 \times 3=12+\frac{1}{4}=12\frac{1}{4}$. Or $9\frac{1}{2} \times 9\frac{1}{2}$ = $9+1=10 \times 9=90+\frac{1}{4}=90\frac{1}{4}$, answer.

The quick and easy way to divide any number by $12\frac{1}{2}$ is: Multiply by 8 and "point off" two places, thus: Divide 250 by $12\frac{1}{2}$. $250 \times 8=2000$, and pointing off two places (always from the right) we have 20.00 as answer. Here is a handy one for squaring mentally. Subtract the number from the next higher tens number. Subtract the difference from the original number; multiply this result by the tens number used, and add the square of the difference. This appears tedious, but a little practice and time will fit you when the occasion arises in comparing the areas of pipes and cylinders. Thus: Take 17; the next higher tens number is 20. $20-17 = 3$. $17-3 = 14$. $14 \times 20=280$. 3 squared $=3 \times 3=9$. $280+9=289$, square of 17.

Drawing from a model is without doubt the best possible means of forming a foundation for a masterly knowledge of draftsmanship. Every draftsman must be able to draw free-hand, as it helps him to form a foundation for masterly knowledge.

Study the subject you intend to draw, reason well, then get to work. Push, pull and bend your larger masses into shape as though you were modeling. This will tend to take away from your work "that flat look."

Cabinet for Drawing Tools.

"A place for everything, and everything in its place," is a motto that should be conspicuously displayed, and religiously followed in every factory, workshop and office, especially in the drafting room, for system is essential to success.

Especially is this applicable to the student. The bed-room, in which a majority of students do their work, is not well adapted to such purposes. The dresser drawers are hardly spacious enough to contain his wearing apparel, and besides, such a drawer is an unhandy place to keep one's drafting tools.

The ideal "place for everything" is a handy wall cabinet. One that occupies no floor space and always in reach. Such a cabinet is shown in the accompanying drawing.

The cabinet may be constructed of any wood, but well-seasoned poplar is probably the best as well as the cheapest. No dimensions are given, as the builder is supposed to suit his own taste and requirements. It should, however, be at least 35 inches long, 17 inches high and 7 inches deep.

Now let us see how this cabinet will take care of the student's paraphernalia. We will begin with the drawing boards.

A double row of small hooks screwed under the cabinet (the rows being about one foot apart and running from front to back), will serve to hang the boards on, corresponding screw-eyes having been attached to the edge of the boards.

The width of the bottom should be at least 14 inches, which will hold five boards. A gathered curtain of silkoline tacked to the bottom edge of the cabinet will add to its appearance and serve to conceal the boards hanging underneath.

The T-square and triangles can be neatly arranged at the back of the center compartment, using small hooks to hang them on. In order to provide for the T-square, this compartment must be a trifle larger than the largest T-square. The back board will also afford ample room for the curves and protractor.

The instruments, pens, pencils and other little tools can be kept in the drawers, of which there are two. These

drawers should be made deep and filled with trays.

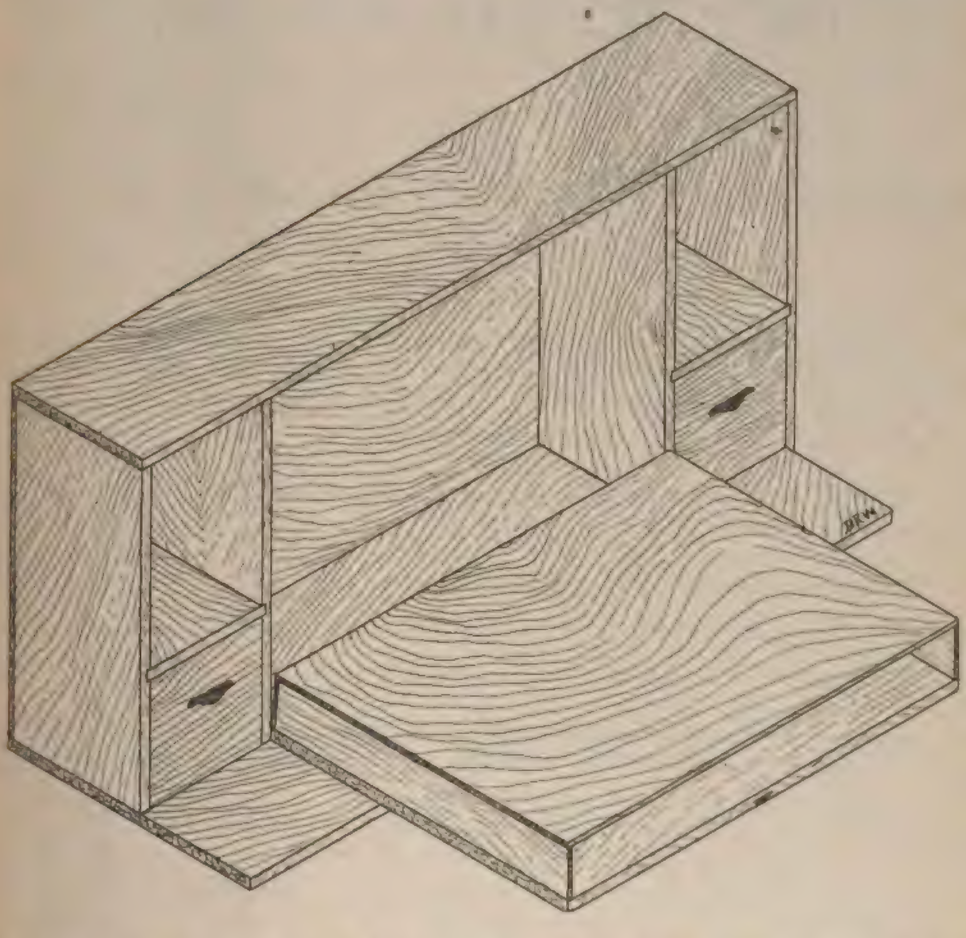
Instead of drawers, let-down doors can be hinged in the compartments, which can then be fitted with sliding trays. The trays should be laid off to fit the various instruments by glueing small blocks of wood in the bottom, after which the trays can be lined with chamois or plush.

The two compartments over the drawers are intended for books, and should be at least nine and one-half inches high.

The center compartment is covered with a let-down door, so constructed as to provide a storage place for drawing paper. The method of construction is plainly shown in the drawing.

The top of the cabinet will serve as a book shelf. Two fancy end pieces may be attached to prevent the books falling off.

The finish of the cabinet depends upon the builder's taste. It may be painted or stained and varnished. The most attractive finish, however, is the dull Mission finish, and it is cheaper than either paint or varnish.



The cabinet can be set on fancy iron brackets, which may be bought for a few cents, and if necessary, it may be further secured by screwing to the wall through the back.

B. R. WINSLOW.

Sample of Drafting Room Instruction Sheet.

KEY TO DRAWINGS.

STANDARD SIZE OF SHEETS ARE: A—24×36, B—18×24, C—12×18, D—9×12.

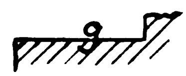
Drawings for complete machine have index letter M. Drawings for part of machine which may be moved from one machine to another, and called a fixture, have index letter F. Dimensions of other small parts of machines, and of objects not properly termed machines, have index letter S.

Each size sheet is consecutively numbered, and a sheet marked "M-2 B-19" would signify Machine No. 2, B size, drawing No. 19.

The index letter also classifies patterns and machine parts. Thus a pattern marked $\frac{\text{F-10}}{1}$ signifies it belongs to Fixture No. 10 and is part No. 1, which would be designated on drawing as F-1, but on sheet indexed F-10.

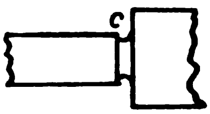
Abbreviations used on drawings: C. I. = Cast iron. M. Steel=Machinery steel. T. Steel=Tool steel. Ph. Br. = Phospher bronze. W. I. = Wrought iron. Mal. I.=Malleable iron. P. D. = Pitch diameter. C. D.=Center distance. P= Diametrical pitch. C. P.=Circular pitch. R. H.=Right hand. L. H.=Left hand. U. S. S.=United States Standard. W. Oiler=Winkley oil hole cover. Scr.=Screw. Gr. Soc.=Grip socket. r=Radius. M. T.=Morse taper. Am. T. =American Taper. C. H.=Case harden. R. P. M.=Revolutions per minute.

Surfaces marked thus are to be ground.



Red lines indicate finished surface on casting when run inside the black ones, showing faint close up to the body lines.

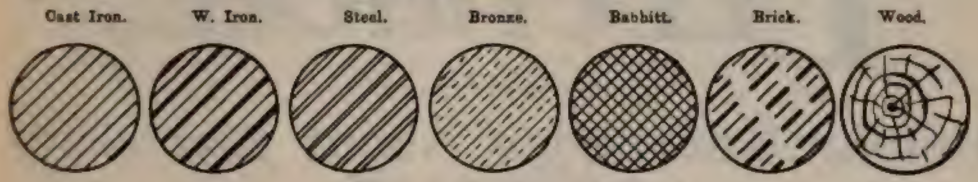
Small c placed in a corner thus



means that a clearance of .005 in. is wanted $\frac{1}{16}$ in. wide at place indicated, and is .500 in. below the finished surface.

Dimensions marked with * are very important, and should be within .001″. Dimensions marked *h* means scale is not correct. T=Teeth. D=Diameter.

Sections of different materials are indicated thus:



Regular drawing lines

Concealed lines

Dimensions lines

Center and pitch lines

ELECTRICAL.

Helpful Knowledge About Electricity.

By EDMUND B. MOORE,
Author of "Wire and Wireless Telegraphy."

PART III.

NEAR the town of Magnesia, in Lydia, was found a certain kind of iron ore that, when suspended and allowed to turn freely, would always point to the North and South Poles of the earth.

It was also found that this ore, often called lodestone, would attract and repel other pieces of iron, steel and the like.

This peculiar property which would attract and repel other similar bodies was called Magnetism. The body having this property is called the Magnet.

The type of magnet just described may be said to be a natural one, because the magnetism naturally existed in the ore. We may, however, take a piece of iron or steel not magnetically affected, and by rubbing it several times with a piece of lodestone, or some other permanent magnet, cause the piece to become affected in the same manner as the lodestone. This artificial magnet is said to have had the property given to it by contact.

Nearly all the magnets in use today are artificial.

We have previously stated that if a magnetic needle is suspended freely it will point to the north and south poles of the earth. The end of the magnet which points to the north is called the north-seeking pole, and the opposite the south-seeking pole.

All magnets possess a north and south pole respectively. The north pole of one magnet will attract the south pole of another, while it will repel the north pole of the other. That is, unlike poles attract and like poles repel. This is a very important law, and from this the foundation of many of our modern electrical instruments is derived.

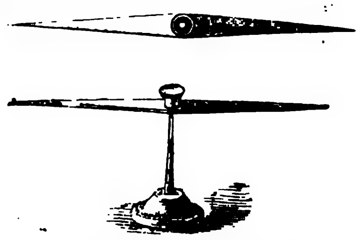


Fig. 9.—Magnetic Needle.

The compass, which is practically a magnetic needle hung upon a needle and mounted over a graduated scale, was supposed by the ancients to always point in the same directions. But it was found that in different places upon the earth the needle would swerve in its direction. This is caused from the earth itself being a great magnet, and its true magnetic poles do not correspond with the geographic poles. It was also noted that in this country the north pole of a magnetic needle or compass was slightly attracted

[illegible]

[illegible]

There are a great variety of different shapes and sizes in which magnets are now made. This depends entirely upon the work they are intended for and the magnet's strength required.

The two most common forms generally seen are the bar magnet and the horseshoe magnet.

[illegible]

reduced by increasing their temperature. That is, if we take a strongly magnetized bar of steel and heat it to a white heat then approach it sufficently near to a magnetic needle, we will find that it scarcely retains any magnetic strength whatever. Upon allowing it to cool gradually the magnetism will return somewhat, but it will never be as strong as before.

It is necessary in cases where horseshoe magnets are in constant use to protect the life of the magnet, that is to prevent the unnecessary loss of the magnetic force.

This is accomplished by placing across the poles of the horseshoe magnet a piece of soft iron, which in this manner connects the two poles and makes a complete path for the magnetism.

Now if we take a magnet and approach it gradually towards a balanced magnetic needle, we will find that the attraction of this needle will increase as the magnet is approached. Upon drawing the magnet away the attraction of the magnetic needle decreases until it ceases altogether. The space around the magnet in which it will cause attraction or repulsion, as the case may be, is called the magnetic field of the magnet. That is, it is the space in which the lines of force from the magnet will penetrate.

The lines of force may be plainly seen by placing a smooth piece of paper over a fairly strong magnet and gently sprinkling iron filings upon this paper. The filings will become themselves little individual magnets by induction and cling to one another, pole to pole, arranging themselves in gradually curved lines, which represent the direction of the magnetic lines of force. The lines of force are very much stronger at the two poles of the magnet, and tend to radiate from the north pole of the magnet through the intervening space to the south pole, continuing again through the magnet itself.

If a piece of iron is held in the field of a magnet or in the path of the line of force, the iron at once becomes magnetically influenced, and the end in which the lines of force are supposed to enter will be the south pole, and the opposite end or the end from which they leave will be the north.

We know, as has been previously explained, that if we approach a magnet sufficiently near, or within this magnetic field of a freely suspended magnetic needle, that the needle will be attracted or repelled as the case may be.

A great scientist named Oersted living at Copenhagen discovered in the year 1820 that if a wire carrying an electric current was held over and parallel to the magnetic needle that the needle would at once be effected by the current and swing around, striving to place itself at right angles with the wire. This fact is however the first of a series of experiments that acknowledged similar relations between magnetism and the electric current, which before this time had been thought to be entirely separate and that one had no effect upon the other.

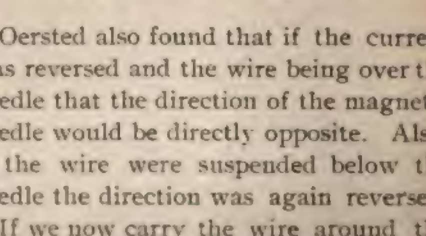


Fig. 12.—Oersted's Law Apparatus.

Oersted also found that if the current was reversed and the wire being over the needle that the direction of the magnetic needle would be directly opposite. Also, if the wire were suspended below the needle the direction was again reversed.

If we now carry the wire around the needle, above and below as shown in the accompanying diagram, the effect pro-

duced by these two wires will continue and increase the deflection of the needle.

By this simple instrument we may determine the direction of the current.

Place the hand palm downward with the fingers pointing in the direction that the current is supposed to flow. When the current is turned on and the needle deflects, the north pole of the needle should point towards the thumb, then the current will be flowing in the direction indicated by the fingers. If the deflection of the needle be renewed and pointed to the little finger, the current will be flowing in exactly the opposite direction as in the first case.

Now if we carry an insulated wire many times around the magnetic needle the de-

These instruments are often called Multipliers, and are of unlimited value in experimenting and laboratory work.

We have learned that the electroscope was used in experimenting with static electricity to determine the existence of a charge. The Galvanoscope may be used with current electricity to determine the existence of weak electric currents.

We have seen that with these instruments the direction of the current may be determined, and the current's magnitude may also be roughly estimated.

An instrument whose construction is very similar to the one previously described is the Galvanometer. It is used to measure the strength of the electric

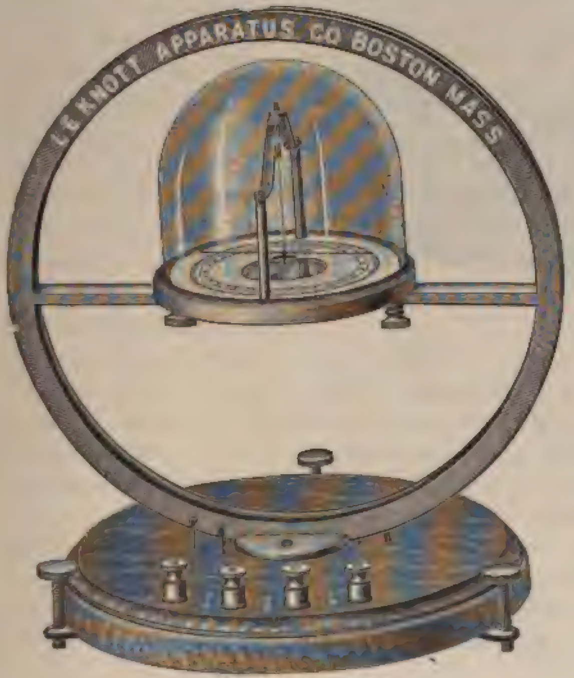


Fig. 13.—Galvanoscope.

flection will be greatly increased and the needle will be effected by a much weaker current.

A piece of apparatus so constructed is called a Galvanoscope. One is shown in the accompanying illustration.

current.

The essential part of this instrument consists of a coil of wire and a magnetic needle.

The magnetic needle consists of two small magnetic needles, suspended by

means of silk from an adjustable screw. The needles are arranged with their poles reversed, and are allowed to turn freely, one over and one under the coil of wire. A graduated dial is placed over the coils to which the top needle points.

Fig. 14.—Astatic Galvanometer.

All this is mounted upon a circular base provided with five adjustable leveling screws, and a glass globe is placed on the whole to protect it from outside injuries. Great sensitiveness is gained by suspending these two equal magnetic needles, and a very slight current will greatly affect the deflection of the needle.

A large variety of makes of these instruments are now upon the market, but space will not permit us to go further into their detail.

A little while after Oersted's discovery in regard to the relation of magnetism to electricity, many important facts were made known by different noted scientists.

Among these Argo furnishes much of importance. He found that whenever a copper wire carried a current of electricity there was a sort of magnetic field around the wire, and iron filings would cling to it in clusters when brought within the radius of the field. It was also demonstrated from these facts that the lines of force which were produced by the electric current were always perpendicular to the direction of the current.

We have stated that a wire carrying a strong electric current will produce a field of force around the wire itself. If we now take and bend the wire into the form of a spiral and pass a strong electric current through the coil, we will find the coil of wire, or Solenoid as it is called, will behave in nearly all respects like a bar magnet. The space within the coil is a magnetic field, and the lines of force flow from end to end. As with the bar magnet the end of the Solenoid from which the lines of force leave is the north pole, and the end into which they enter is the south pole.

We know that a magnet attracts unlike poles and repels like poles. It is exactly the same with the Solenoids. If we have two Solenoids, one somewhat larger than the other, and the smaller free to move in and out of the larger one, we will find that if a strong current is sent through the two coils, and the two ends nearest being unlike poles, the two will attack one another, and the smaller one will be drawn within the larger. If the two poles were the same, repulsion would take place and the two would separate somewhat. If the current in each coil is flowing in parallels, attraction will take place, but if not, repulsion. It has been found that if two wires carrying a current form an angle to each other, they will tend to become parallel, and therefore the current will flow in the same direction.

We stated previous to this that the lines of force within the Solenoid acted similar

to a magnet. Now if we place a bar of soft iron within the coil the lines of force are enormously increased. The soft iron increases the number of lines of force and prevents them from escaping as was in the latter case. Iron offers much easier path to the lines of force than the air. Technically speaking we say it has much greater permeability than air.

These facts as above explained are of great value in the progress of electrical science.

Now if substituting soft iron for the air space in the Solenoid greatly increases the magnetic force, why not take a soft bar and wind the wire around it in the first place? This is exactly what is done. A soft iron rod wound with a number of turns of insulated wire is called an electric magnet.

Electric Magnets are made in many shapes, sizes and styles. The use to which they have been put is inconceivable as regards their commercial value.

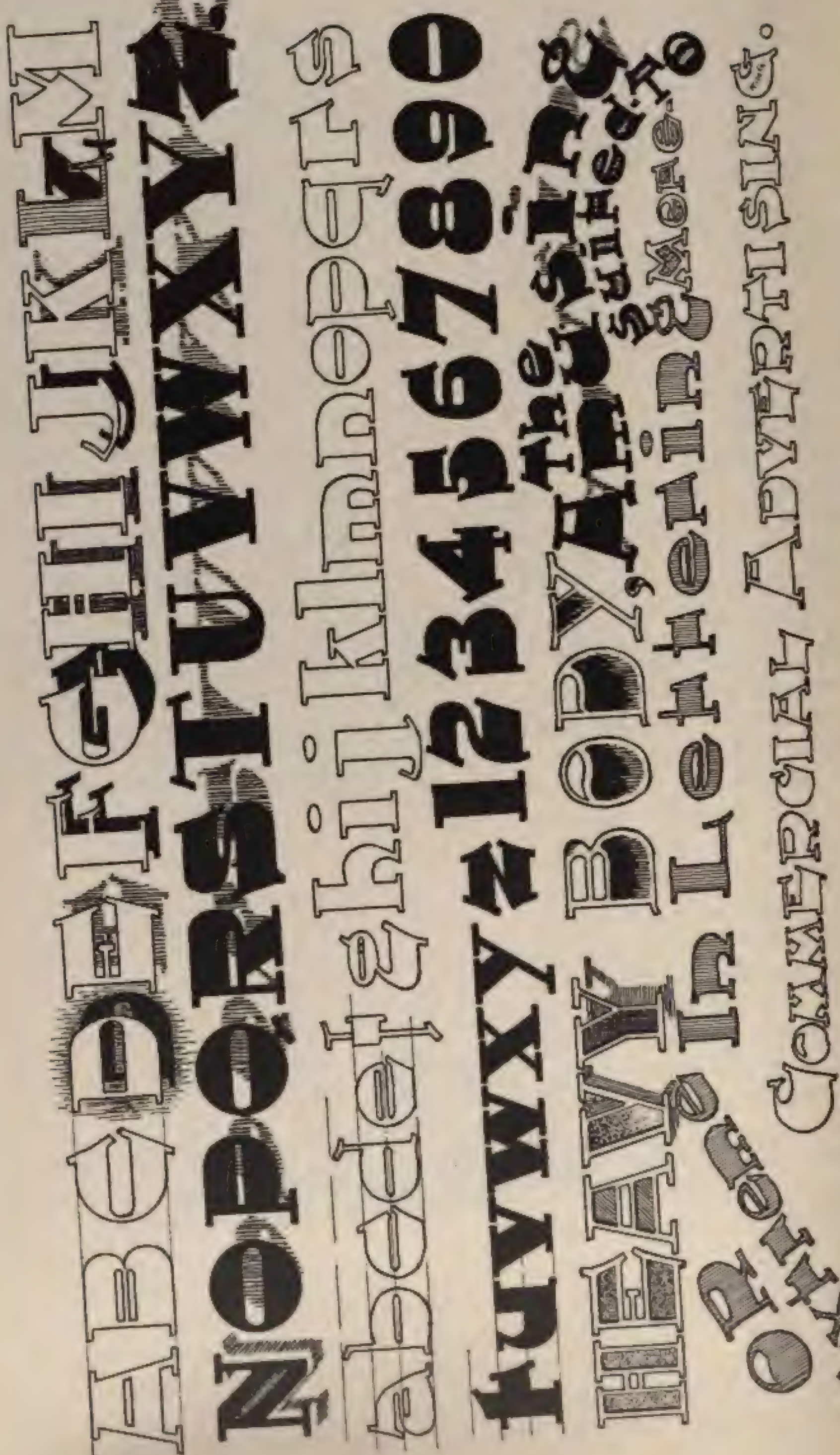
In the next chapter we will take up their description and give the reader a general idea of their use and uses.

(*To be continued.*)

New Metal Creation.

Tantalum is a metal creation of Werner Von Bolton, and is not only ductile, but in a marvelous manner becomes extremely hard after hammering. A sheet of tantalum one millimeter thick was drilled with a diamond drill making 5,000 revolutions per minute for seventy-two hours, and was then found to have a depression of about one-quarter of a millimeter, the diamond drill being much worn. It is as useful in electric glow lamps as carbon, while the electrical energy consumed is less than one-half. It is not attacked by aqueous solutions of the alkaloids, and by only one acid,—hydrofluoric, whose action upon it is extremely slow. Because of its strength and hardness, tantalum and its alloys, it is hoped, will be used in making engineers' machine tools.

Credit should be given *The Engineer* for the article on page 325 by Mr. Frank Kleinhans.



Au illustration taken from "Lettering."

HOME STUDY.

The Value of Mechanical Drawing.

By WALTER S. WOOD.

PROBABLY there is no other acquirement among all the various classes of educational training that so thoroughly combines pleasure with profit as the ability to make drawings. It is a great source of delight and honest pride to be able to be able to make drawings intelligently, for he who can draw correctly, even though roughly, wields a language more direct and clearly understood than any which can be expressed in words. It enables one to say that which could not otherwise be said, and to see that which could not otherwise be seen. It is a language of itself, a mode of expressing ideas, an intelligible means of communicating thoughts, and really the only universal language. The ability to reproduce on paper in an intelligent manner that which the mind concerns, or the eye sees, is to possess a most rare and valuable faculty.

In all the avocations of life at the present time mechanical drawing plays a most inportant part as it is brought into continued used as an acquisition to nearly every pursuit or occupation, owing to the fact that nearly every new machine, architectural or engineering structure from the smallest cottage to magnificent "sky scrapers," the mammoth ships of our navy with their monster guns and powerful machinery which equips them, are first planned and built upon paper by means of the art of mechanical or constructive drawing.

In pursuits of a mechanical nature, the range of its ability to serve is almost boundless, to say nothing of the things in which it is absolutely indispensable. In these it becomes not merely an aid but a necessity to the greatest proficiency, not alone to the professional draftsman, but to the inventor in perfecting his invention, the man of science in directing the construction of his apparatus, the engineer in planning some public improvement of great magnitude, the pattern maker, the machinist, the boiler-maker, the sheet metal worker, in fact all of whatever calling or occupation. All these, in order to execute designs intelligently, must at least be able to read drawings, agd surely would be none the worse workman if able to make them also.

How often do we hear those engaged in mechanical pursuits, who would be greatly benefited by a knowledge of mechanical drawing, express themselves as to inestimable value in about such terms as these; "I would give anything if I could make drawings," or "I would give one hundred, or five hundred or a thousand dollars just to be able to make drawings for my own use. There are thousands engaged in these very pursuits as journeymen and apprentices, seemingly

conscious of this, who are making no effort to acquire the knowledge which would be so valuable to them.

But suppose we put these people to the test, I will venture the assertion that eight out of ten would not give one cent to learn, because with the advantages now offered everyone by correspondence instruction this knowledge can be satisfactorily acquired during spare time from their daily vocation at a total expense not exceeding $30. Surely it is not the lack of money or the time that prevents them from learning, but the lack of effort, for they waste in frivolous amusement, if nothing worse, time enough if put to proper use to become quite skillful in the art of drawing. They should not be surprised to find themselves surpassed by their more energetic comrades. Leisure time can hardly be put to a more commendable use, or more profitably employed than in the practice and study of the principles of mechanical or constructive drawing, by both young and old, for it is one of those things which it is never too late to learn.

Mechanical drawing is not difficult to learn,—in fact it is easy. Neither does it require a costly outfit of instruments, or a knowledge of mathematics beyond the limits of an ordinary common school education. We would not deny that a knowledge of geometry and the higher mathematics would be of great use, but we do say that anyone sufficiently intelligent to be even a good apprentice at any of the mechanical trades can, if he will make the effort and resolutely try, in a short time become competent to produce drawings which will be both creditable and useful to him.

A child learns music not by waiting until he understands the principles of acoustics and harmony, but by continued practice of exercises which train the fingers, and he is master of the mechanical difficulties long before he knows what acoustics means; and so anyone may begin the practice of mechanical drawing, as he began writing, in a mechanical way, and it will be strange if by the exercise of a little common-sense he does not gradually gain an insight into the principles which underlie the practice.

A Correction.

In our October issue in the the article headed "Hydrostatics," there was an expression as follows:

"$7824 \times 24 \times 24 = 452.39$ sv. in."

This should have been printed:

"$.7854 \times 24 \times 24 = 452.39$ sq. in."

We are indebted to Mr. L. L. Lee, of Boise, Idaho, for correction of this oversight.

CURRENT TOPICS.

Mr. "Beam Compass" gives us a good letter on a society for draftsmen. There should be more comments on this subject.

We have added about 1,500 draftsmen to our mailing list in the past two months. Have you sent in your list?

If you have had experience in forming a society, write the editor about it. Your ideas will help more than from one who theorizes.

Perhaps you see some changes in our pages this month. There are more to come, for the staff of THE DRAFTSMAN has been increased by three, and the editor will now have more time to devote to the reading pages.

The coupon offer contest which has been advertised to close Oct. 31, 1905, has been extended to Jan. 1, 1906. Get more coupons, and try for the prizes. Send for circular and coupons.

Westinghouse Called Wallace.

It is now understood that the $65,000 position for which John F. Wallace resigned as the chief engineer of the Panama Canal was in connection with an electric railway scheme headed by George Westinghouse. The idea was to build electric lines in all parts of the country where they can compete with steam railroads, but as soon as a line was completed it was to be transferred secretly to the competing railroad. Besides this, existing electric lines were to be coerced into selling out to the Westinghouse corporation.

Comments and Personals.

Vox Populi's complaint is against a poorly run office,—an expensively run one. To prove this so, can say the largest employer of draftsmen in the country pays his men by the hour, and the engineer (among the score) making the best showing on cost of drawings is one who does not want any of his men to work more than 44 hours per week. He would rather pay one dollar per hour for 44 than fifty cents per hour for 60, and when his figures "reach Broadway" they read better than anyone else's. This is not a mere assertion, but a positive fact, which can be proved to any "buyer of dimensions." The "buyer of dimensions" is the fellow we draftsmen sell our time to, and if he ill-uses us, the very best way to get along with him is in the protection of striking back by not being afraid of being fired,—the finest man in the world to work for is one who is not afraid of his job.

H. G. Garver, a checker at the American Bridge Co.'s Toledo office, has gone to the Missouri Valley Bridge Co.'s office at Leavenworth, Kansas.

J. E. Persing has been transferred from the Toledo to the Minneapolis office of the American Bridge Co.

It is understood the new president of the American Bridge Co. is a believer in

the drafting room being at the shop, which is a good thing for draftsmen in number required and net pay from living outside a city skyscraper.

S. C. Barr has been promoted from office draftsman to field inspector by the Arnold Electrical Construction Co., Chicago. H. C. T.

Civil Service Examinations.

The U. S. Civil Service Commission announces an examination on Nov. 29, 1905, to secure eligibles to fill the following vacancies: Fireman (Class B) in the State, War and Navy building, at $720 per annum; electrical inspector, in the Quartermaster's Department at Large at $1,500 per annum; ink chemist and ink maker, at $2,000 per annum, in the Bureau of Engraving and Printing.

The Commission also announces an examination on Dec. 6, 1905, for mechanical draftsman on the Isthmus of Panama at $1,200 to $1,800, but usually $1,500, per anuum; also electrical assistant in the Signal Service at Large, for a period not exceeding six months, at the rate of $75 per month during such employment, and one permanent vacancy at $900 per annum at Washington, D.C.

Applicants should address the U. S. Civil Service Commission, Washington, D. C., for blanks and information.

Can You Answer These?

Is the convexity of the new moon toward the sun or away from it?

Why do shoes creak?

Why do shoes take a polish from blacking?

Do vines turn the same way as the threads of a screw?

Why is dew not formed on cloudy or windy nights?

Which feet of a horse are on the ground when he gallops, runs, trots or canters?

Why does plate glass reflect better than ordinary window glass?

What is the difference in the motion created by steam and electricity?—*Ex.*

A New Grindstone.

George Stolzenberg, of Berlin, Germany, has patented in this country an improvement in grindstones, which relates more particularly to means for effecting an automatic supply of water to the grinding surface from the axis thereof through the body of the stone. In the embodiment of the invention, the grindstone is secured on a revoluble shaft, which shaft is provided with an internal chamber tapering from the eye of the stone outwardly, and provided with radial ports leading from the chamber directly to the eye. Means are provided to prevent the escape of liquid from opposite ends of the eye of the stone, and a feed-pipe is employed which is stationary relatively to the shaft and fitted fluid-tight in the smaller end of the shaft chamber, whereby when the shaft is rotated, a partial vacuum is formed in the chamber and water drawn in by suction and driven through the body of the stone to its periphery by centrifugal action.—*The Inventive Age.*

A Chance for an Inventor.

"Gee! I wished I was an inventor!" exclaimed Jimmy, loafing outside the base ball park.

"W'at fur?" demanded Mickey.

"I'd invent a knothole w'at yer could carry 'round wid yer and stick in a fence anywheres yer pleased."—*Ex.*

"Now," said the teacher, who had been giving an elementary talk upon architecture, "can any little boy tell me what a 'buttress' is?"

"I know," shouted Tommy Smart. "A nanny goat."

Another Proposed Constitution and By-Laws.

The following is suggested by Mr. A. B. Hayes, of Milwaukee, as suitable for a draftsmen's society :

CONSTITUTION.

ARTICLE I.

NAME AND OBJECT.

Section 1.—The name of this society shall be known as the American Operative Draftsmen's League.

Sec. 2.—The objects of this organization shall be: To unite fraternally and socially persons of good moral character engaged in drafting ; to especially train its members in those branches of practical education which have direct bearing upon the work of drafting; to originate and circulate literature relating to the science of drafting, and to standardize, as much as possible, drafting practice, and the adoption of such rules to govern the same ; to afford its members the advantage of lectures on drafting and kindred subjects ; to set aside a Relief Fund for its members in case of sickness, injury or disability, and to provide funeral benefits in case of death ; to establish and maintain a bureau of information for its members, and to provide those in good standing with credentials when traveling.

ARTICLE II.

QUALIFICATIONS FOR MEMBERSHIP.

Sec. 1.—All applicants must be white male American born or naturalized citizens, residents of the jurisdiction of the Drawing Room to which the applicant for membership applies.

Membership of the League shall be divided into three classes : Active, Associate and Honorary members, who will become such upon application to a Drawing Room of the League, and by vote of two-thirds of the members present. Only Active Members are entitled to vote or eligible to office. The Associate Members shall be entitled to all privileges of the Drawing Room except those stated above.

Sec. 2.—The Active Membership shall be made up of operative draftsmen, designing or detailing work for at least two years. The Associate Membership shall be made up of elementary detailers, tracers and blue print boys not less than 18 years of age.

Sec. 3.—Chief draftsmen, engineers, architects and other officials directly interested in drafting, desiring to be associated in the Drawing Room work, may be elected to Honorary Membership.

ARTICLE III.

DUES.

Sec. 1.—Each Active Member shall pay dues to the Drawing Room amounting to $4.00 per annum, payable semi-annually in advance, on March 1st and September 1st.

Sec. 2.—Each Associate Member shall pay dues to the Drawing Room amounting to $2.00 per annum, payable semi-anuually in advance on March 1st and September 1st.

Sec. 3.—All dues shall be paid to the Secretary of a Drawing Room, and disbursed by order of the Chairman.

Sec. 4.—No member shall be in good standing in the Drawing Room who fails to pay such dues.

Sec. 5.—Honorary Members shall be exempt from the payment of dues.

ARTICLE IV.

GOVERNMENT.

Sec. 1.—The elective officers of the League shall be a Chief (president), Assistant Chief (vice-president), League Foreman (secretary), League Draftsman (treasurer), and a board of six Directors, who shall be elected by a majority vote of the League Representatives present at the annual convention, held the first week in October at a place celected by that body.

Sec. 2.—The officers of a Drawing Room shall be a Chairman, Vice Chairman, Secretary and Treasurer, who shall be elected by a majority vote of the members present at the last regular meetings in June and December.

Sec. 3.—A Drawing Room shall elect three Trustees, one to serve one year, one to serve two years, and one to serve three years ; and at each annual election thereafter they shall elect one Trustee to serve three years.

Sec. 4.—Each Drawing Room shall be entitled to one League Representative for each 25 members. They shall be elected annually at the same time and in the same manner that the officers are elected at the regular meeting in June of each year. They must be bona-fide residents of the jurisdiction wherein their Drawing Room is located.

Sec. 5.—In case of a vacancy occurring in the office of a League Representative, the Chairman shall appoint an Active Member to serve. Credentials for the appointee under this section must be sent to the League Foreman.

Sec. 6.—League Representatives shall be furnished certificates in proper form, and shall attend the sessions of the League and therein faithfully represent their Drawing Room, and

at the next regular meeting of the Drawing Room thereafter they shall individually or conjointly make a report in writing on all matters of interest transacted by the League sessions.

Each Drawing Room shall provide a regulation badge for its Repsesentatives.

ARTICLE V.

MEETINGS.

Sec. 1.—The place of holding meetings shall be known as a Drawing Room, to consist of not not less than ten draftsmen members of the Active class. It shall be styled and known by the name of the county in which it is located.

Sec. 2.—The jurisdiction of a Drawing Room is to be confined geographically within the boundary of the county of the State wherein it is situated.

Sec. 3.—The members of a Drawing Room may rent a suitable hall or place for the transaction of business, and shall hold regular meetings at least once a week at such hour as may be determined upon.

Sec. 4.—Seven Active members shall constitute a quorum for the transaction of business, but if seven members only are present, no appropriations can be made unless it be by unanimous consent.

Sec. 5.—Special meetings of the Drawing Room may be held as the business may require, but they shall be confined to the business for which they were called. The Chairman may call such meetings at his own discretion, and must when requested to do so in writing by five members of the Drawing Room.

Sec. 6.—Every Drawing Room shall be opened at the appointed hour, and in the absence of the Chairman the Vice-Chairman shall preside; and in the absence of these an Active member may be called to the chair by a majority of the members present.

ARTICLE VI.

RELIEF FUND. (Optional.)

Lec. 1.—The Trustees shall have general supervision of the affairs of the Relief Fund. They shall decide who are entitled to benefits, and to that end may employ a reputable physician, by contract or otherwise, to visit sick and disabled members. The decision of the Trustees shall be final and without recourse to any court whatever.

Sec. 2.—The Trustees shall have power at such times as in their judgment it is just and necessary to levy an assessment on the members of the Relief Fund to meet the contingencies of excessive sickness, accident or death, provided, however, that such assessment shall not exceed fifty cents, and not levied more than twice in one year. Further assessments may be levied by a two-thirds vote of the members present at a regular or special meeting.

Sec. 3.—The Chairman shall preside at all meetings, and upon notice of the sickness of a member, he shall appoint a visiting committee of two, whose duty it shall be to visit the sick member as soon as possible thereafter and report his condition in writing within forty-eight hours to the Chairman. Members of such visiting committee failing to comply with the above will be fined $1.00 each.

ARTICLE VII.

DUES AND BENEFITS.

Sec. 1.—The dues shall be twenty-five cents, payable monthly in advance to the Secretary at any regular meeting.

Sec. 2.—Any member of the Relief Fund in good standing, unable to attend to his duties through sickness or disability, must notify the Secretary at once of the date of such sickness or disability, and shall be entitled to receive out of the funds not more than $5.00 per week, Sundays included, for a period of thirteen weeks.

Sec. 3.—No benefits shall be paid to a member for the first week of sickness, or disability, but thereafter he shall be paid for the actual number of days he is sick or disabled for a period not to exceed thirteen consecutive weeks.

Sec. 4.—If any member entitled to benefits, and having drawn the same, is again taken sick within a period of four weeks, such second sickness shall be considered as a continuation of the first sickness, and he shall only be entitled to benefits for such a number of days as added to the previous term of sickness shall make thirteen weeks.

Sec. 5.—Any member having drawn benefits for the full term of thirteen weeks shall not be entitled to further benefits until he shall have been at work for a period of not less than twelve weeks, unless the Trustees shall authorize payment sooner.

Sec. 6.—No benefits shall be paid for any sickness, injury or disability arising from intemperance or from any immoral act on the part of any member.

Sec. 7.—On the death of a member in good standing a funeral benefit shall be paid to his legal representatives, consisting of $25.00, within five days after due notice has been given to the Secretary.

Sec. 8.—Any member of the Relief Fund detected in obtaining or attempting to obtain benefits fraudulently shall, on conviction of the Trustees, be expelled from the Drawing Room by order of the Chairman.

ARTICLE VIII.

DUTIES OF OFFICERS.

Sec. 1.—It shall be the duty of the Chairman to preside over and preserve order during sessions of the Drawing Room, appoint all committees (unless otherwise ordered by the Room or the laws of the League), to decide all questions of order without debate (subject, however, to an appeal to the Room), and perform such other duties pertaining to his office as may be prescribed in the laws of the League and By-Laws of his Room. He shall appoint at the last meeting in June a committee of three Active Members to audit the books and accounts of the Secretary, Treasurer and Trustees. He shall sign all orders on the Treasury which are ordered by the Room, and all other papers requiring his signature.

Sec. 2.—It shall be the duty of the Vice-Chairman to preside in the absence of the Chairman, and he shall then be vested with all the rights and duties of the Chairman.

Sec. 3.—It shall be the duty of the Treasurer to make a semi-annual report of the finances of the Room, and transmit it together with a certificate of the per capita tax (?) to the League Foreman. Within twenty days after the close of his term he is to deliver any funds, documents or other Room property that he may have to the proper officers, and to faithfully perform all duties prescribed by the Constitution and Laws of the League. For the faithful performance of his duty he shall before taking charge of the office of Treasurer give bond in double the amount of funds likely to be received by him, with two sureties to be approved by the Room.

Sec. 4.—The Secretary shall keep an accurate account between the Room and its members, notify all members who are in arrears, keep just and impartial record of all the proceedings of the Room, conduct all its correspondence, receive all moneys, giving his receipt therefor, keep an exact and true account of all moneys so received, and pay the same over to the Treasurer, taking his receipt therefor, make no disbursements unless authorized to do so by the Room, under order of the Chairman and attested by the Treasurer. He shall make a summary report monthly of the essential proceedings of his Room to THE DRAFTSMAN for publication. Make out and present to the Room his report at the expiration of the semi-annual term, and perform all other duties required of him by the laws of the League and By-Laws of his room. He shall give bond in double the amount of funds likely to be received by him, and approved by the Room.

Sec. 5.—The Trustees shall have general supervision and care of all Room property. All moneys ordered by the Room shall be used for the purpose intended, and drawn from the Treasurer, giving a voucher for all investments made to the Treasurer for safe keeping. They shall be the finance committee of the Room and of the Relief Fund (should there be any), and shall make a correct statement in writing of the financial condition of the Room at the last regular meeting of the term, and perform such other duties as may be required by the laws of the League and By-Laws of the Room. They shall each give bond in double the amount likely to be received by him, to be approved by the Room.

Sec. 6.—No member shall hold two offices in a Room at the same time unless it be that no other competent member will accept the office.

ARTICLE IX.

DUTIES OF LEAGUE OFFICERS.

Sec. 1.—It is the duty of the Chief to have full authority and supervision over all the Rooms of the League, to preside at the League sessions, appoint a majority of all committees and of officers pro tempore in case of temporary absence or disqualification of an officer, to decide all questions pertaining to the laws of the League. He shall sign all orders, drafts, charters and papers of the League requiring his signature to authenticate them, and perform such other duties of his office as are now or hereinafter prescribed by the Constitution and Laws of the League.

Sec. 2.—It is the duty of the Assistant Chief to assist the Chief in preserving order and decorum in the League sessions, appoint a minority of all committees, to preside in the absence of the Chief, and be vested with all the rights and duties of the Chief.

Sec. 3.—The League Foreman shall keep an accurate account of the proceedings of its sessions, conduct all its correspondence, have charge of the League seal, receive all moneys, and immediately pay the same over to the League Draftsman, taking his receipt therefor; make out and present to the National Convention of the League his report of the affairs of the League. He shall record all Rooms that have not paid their per-capita tax (?), together with a list of their officers and representatives not entitled to a seat in the Convention of the League. He shall give bond in double the amount likely to be received by him, with two sureties, to be approved by the Board of Directors.

Sec. 4.—The League Draftsman shall receive from the League Foreman all moneys received by him, giving his receipt therefor, keep an exact and true account of all moneys so received, make such disbursements authorized by the Chief and attested by the Foreman and the League seal. He shall make a full report to the National Convention of the League, and at the end of his term deliver to his successor all funds, books, papers, accounts, seal and other property of the League. For the performance of his duties he shall give bond in double the amount likely to be received by him with two sureties approved by the Board of Directors.

Sec. 5.—The Chief shall officiate at the sessions of the Board of Directors. It shall be the duty of the Board of Directors to advise the Chief for the welfare of the League, to direct and maintain all the supplies of the League, to devise means for the creation of new Drawing Rooms and interest in the maintenance of the organization, to conduct and keep a record of all transations and proceedings of that body, and submit a report annually to the League Convention.

ARTICLE X.—AMENDMENTS.

Sec. 1.—These Laws may from time to time be amended as the League Representatives may determine, provided such amendments do not conflict with the intent and purpose of such laws. All amendments must be offered in writing and their adoption shall require a two-thirds vote of all members present.

Sec. 2.—The Laws of the League shall be published in book form annually, and copies furnished to each officer of the League.

BY-LAWS.

ARTICLE I.

RULES OF ORDER.

Sec. 1.—For Rules of Order, Roberts' Rules of Order shall be the guide.

Sec. 2.—Order of Business:

(1) Calling of roll of officers, and noting absentees (2) Reading of minutes of regular and special meetings (3) Sickness or disability of any member (4) Report of Relief Committee. (5) Report of Membership Committee (6) Applications and admissions to membership (7) Reports of standing committees (8) Communications and notices. (9) General business (10) New business. (11) Good of the League (12) Adjournment

Book Reviews

Rafter and Brace Tables, by H. T. Aurlie, Architect, the Industrial Pub.Co., 16 Thomas St., New York, sellers. These tables are designed for the convenience of Architects, Builders, Carpenters, and the Building Fraternity.

A catalog of calculating rules has been received from Kolesch & Co , 138 Fulton St., New York.

Weed, Cal., Sept. 16, 1905.
THE DRAFTSMAN, Cleveland, O.

A short time ago I sent you 25c. for a four months subscription to your paper. I have received but one copy, but am so pleased with it that I enclose $1.00 more. If you have back numbers of 1905, you may commence my subscription Jan. 1, 1905, by sending back numbers up to September. I notice you are offering a list of supplements and data sheets as premiums. I would be pleased to receive same.

C. H. COOPER.

The prizes offered by "Engineering News" and the "Cement Age of New York for the best papers on "The Manufacture of Concrete Blocks and their Use in Building Construction" have just been awarded by the Jury, which was composed of Messrs, Robert W. Lesley, past president of the American Cement Manufacturers' Association; Richard L. Humphrey, president of the Cement Users' Association; and Prof. Edgar Marburg, secretary of the American Society of Testing Materials

The first prize of $250 was won by a paper by Mr. H. H. Rice of Denver, Colo., secretary of the American Hydraulic Stone Company. The second prize of $100 is given to a paper by Mr. Wm. M. Torrance, C. E. of New York City, assistant engineer in charge of concrete-steel design for the Hudson Tunnel Companies.

Failings of Young Engineers.

Charles F. Scott says it is easier to train engineers than men with manhoods quota of courage, backbone, moral strength. "College courses are apt to give 99 per cent. to technical subjects and 1 per cent to culture studies. When older men talk about the value to an engineering student of a debating society, of familiarity with parliamentary practice, of fluency in composition, of culture studies, of the training in effective co-operation, of education as a means of forming right habits and developing the faculties as well as acquiring technical knowledge, the student in engineering does not seem to know what they mean." An engineer of wide experience says that in selecting young engineers for specific work he found a greater number were lacking in moral qualificanions than in technical ability.

Correspondence.

EDITOR, THE DRAFTSMAN.

Dear Sir:—I have received only two copies of your magazine, and although I realize that the paper is in its infancy. I have read them all through and appreciate the effort you are making to have it a successful and helpful paper for the profession. I am also pleased that you gave it the name that you did.

I enclose a list of the names of 63 draftsmen with whom I am acquainted and have given you sufficient address to insure safe delivery of mail.

In regard to data sheets, I have quite a large collection and later am going to send some for publication.

[illegible]

[illegible]

New Inventions.

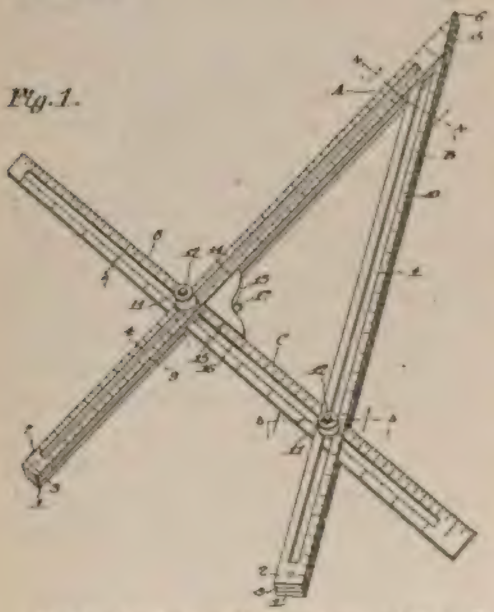
The following inventions have been specially reported for THE DRAFTSMAN by C. LeRoy Parker, solicitor of patents, 707 G street, Washington, D. C.

MEASURING IMPLEMENT.

No. 798,696, Oscar Osmonson, Sept. 5, 1905.

This invention is a device for constructidg triangles practically from the necessary data and then measuring on the implement the unknown parts to avoid calculation.

Fig. 1.



Referring to the illustration, side C is adjusted with reference to A and B, and is secured at any desired adjustment by means of binding screws, extending through the slot in C and through the slots in A and B, said screws being provided with thumb-nuts. The binding screws being freely slidable in the respective slots when the nuts are loosened, the three parts A, B and C may be adjusted with relation to each other to present the sides of any desired triangle and may be secured in the desired position by tightening the nuts. The measuring scales upon the faces of the respective sides will indicate the relative lengths of the sides of such triangle.

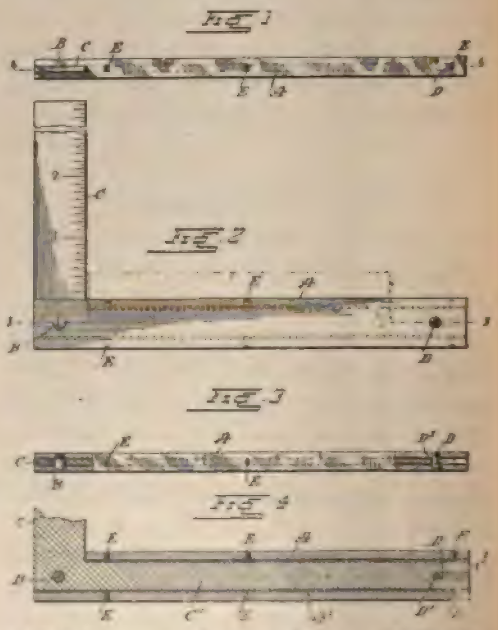
For the purpose of enabling the implement to be accurately adjusted with two of its members at right angles to one another, a block 13 is provided, said block having two sides at right angles to each other, and provided on one side with a flange which engages a slot in the side C, upon which it may be clamped securely by a set screw 17.

ADJUSTABLE SQUARE.

No. 801,065, Randall MacDonald Dixon, October 3, 1905.

This invention relates to measuring instruments, the object in view being to provide an adjustable square arranged to permit adjustment of the blade relative to the base to set the members of the square accurately at a right angle one to the other.

The base A of the square is provided at or near one end with a pivot B, on



which is mounted to swing a blade C, having the usual graduation, and from the pivotal end of the said blade C ex-

tends integrally an adjusting arm C', arranged lengthwise in a longitudinal opening A', formed on the base A, so as to be concealed within the base.

On the outer end of the angular arm C8 is formed a longitudinal slot C2, engaged by an eccentric pin D, extending transversely and in the form of a set screw in tne base A.

By the operator turning the eccentric pin D with a screw driver an up or down motion is given to the angular arm C', and consequently to the blade C, to permit of bringing the blade C accurately into a right-angular position relative to the base A. When this adjustment has been made, then the angular arm C' is locked against swinging movement, and for this purpose a number of set screws E are employed, screwing in the top and bottom of the base A against the top and bottom edges of the angular arm C'.

In case the square gets out of true, then the operator unscrews the set screws E and turns the eccentric pin D until the blade C is brought back into an accurate right-angular position relative to the base A, and then the set screws E are again screwed up to lock the angular arm C', and consequently the blade C, against movement.

RULE.

No. 798,721, Lewis A. Wilson, Sept. 5, 1905.

This invention is a new T-square with an adjustable head and elongatable, graduated rule, as shown in the illustrations. The rule can be set at any desired angle with the head. The scales 5 are on both sides of the rule and are made in sections, which are movable, sliding in grooves in the fixed part 4. After being pulled out their edges form a continuation of the ruling edges of the fixed part 4, so that lines of great length may be made.

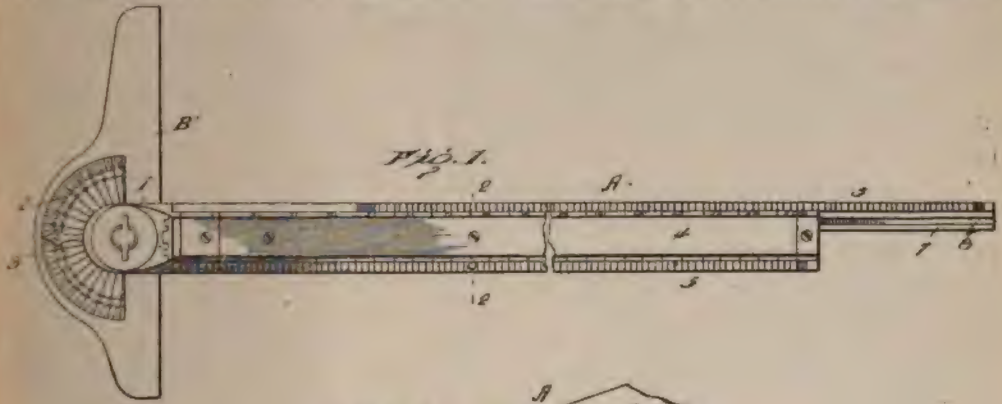


Fig. 1.

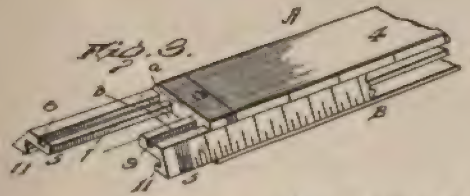


Fig. 3.

IMPLEMENT FOR DETERMINING ANGLES.

No. 800,964, Harry H. Winship, Oct. 3, 1905.

The illustrations show a square with the usual graduations and an angle measuring device added thereto.

Blade 10 is 24 inches long, and another blade 11, commonly called the "tongue," disposed at right angles thereto, is 18 inches long. Both blades are graduated in inches and fractions of inches.

The angle measuring devices comprise

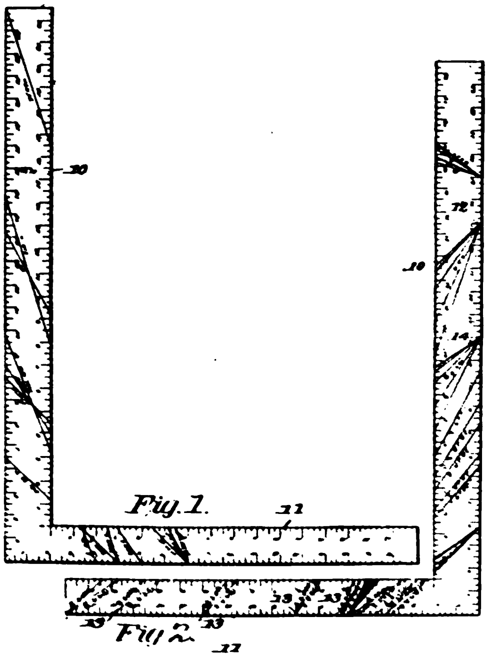
a number of lines radiating at predetermined angles from a common point on the base member, and other lines radiating at from one or more terminals of the first mentioned lines, and extending thence over the base member and concentrating at a common center.

The radiating lines are made by cutting into the face of the metal in the same manner as the ordinary graduations are formed, and commence as at 12, and on one blade radiate therefrom and extend over the other blade 11, and terminate, as at 13, at the outer edge of the same. From one or more of the terminal points, 13, other lines radiate and extend across both blades and terminate, as at 14, at the outer edge of the blade 10. The lines from the terminals 13 concentrate at a common point 14 on the blade.

The obverse surface of the implement represented in Fig. 1 is provided with lines disposed at angles which correspond to the angles of various geometrical figures,—such as octagons, hexagons, pentagons and the like,—as well as one line leading from the eight and one-half inch mark on the blade to the six-inch mark on the tongue.

A line is also arranged from the five inch mark on the tongue to the four and seven-sixteenth inch mark on the blade, the distance on the blade corresponding to the side of a square and the distance on the tongue corresponding to the diameter of a circle of approximately equal area. A line is also arranged from the four-inch mark on the tongue to the nine and seven-tenths inch mark on the blade, the longer distance corresponding to the diameter of a hexagonal figure measured between the flat surfaces and the shorter distance corresponds to the width of one of the flat surfaces of the same figure. The graduations for the seven and seventeen inch marks of the blade are extended inwardly to define them more clearly, and the distance between these marks (ten inches) is equal to one of the flat surfaces of an octagonal figure, the diameter of which, measured between the flat surfaces, is equal to the whole length of the blade, or twenty-four inches.

In the small figure is shown the manner of ascertaining the approximate circumference of a circle from the diameter, which is done by first setting the bevel to correspond to the angle leading from the five-inch mark on the tongue to the four and seven-sixteenths mark on the



blade to obtain the proper angle, and then set the bevel implement upon the tongue of improved implement at the mark corresponding to the diameter of the circle it is desired to measure, when the graduation which the blade of the bevel reaches on the blade will denote the circumference of the circle approximately. Thus the circumference of any circle within the range of the tongue portion of the implement may be quickly ascertained. It will be obvious that given the circumference of any figure the diameter may be as quickly ascertained by merely reversing the action.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Tool Drafting.

By S. E. BOYNTON.

LESSON V.

IN order to keep up with the procession the manufacturer of today must practice economy in every branch of his business, and systematize his factory in every department down to the most minute detail. This is especially so of the manufacturer of standard machines, like typewriters, sewing machines, and printing presses, where competition is keenly felt, and the cost of production must be kept down to a minimum.

A modern manufacturer constructs his machine in such a manner that all parts are interchangeable; a part may be taken from one machine and placed in another without impairing its working qualities in the least. In these days of close competition machine parts must go together without a hitch; they must assemble as they come from the machine on which they were manufactured, without so much as a rub of a file.

An order being received at the factory from some distant part of the globe to replace a broken machine part could be filled immediately; for the part would be taken from stock and forwarded to its destination with the assurance that when it arrived it would fit into place just as desired, no alteration being necessary. This confidence would not be possible did they not know that the part was an exact duplicate of the original.

To make two or more pieces exactly alike, they must be made to accurately conform with some standard gauge which shall indicate any variation. Without the aid of gauges, it would be impossible to construct a number of machines similar in design and have them a commercial success, for it is the only positive means of duplicating parts. Some concerns are more exacting than others, and enter into very elaborate systems of gauging. One of these systems consists of the

construction of three similar gauges for every important part and point on their machine. One of these gauges is kept in the vault, where it can not be tampered with, and is called a "master gauge;" should any dispute arise between the shop foreman and the inspector about a particular gauge, the

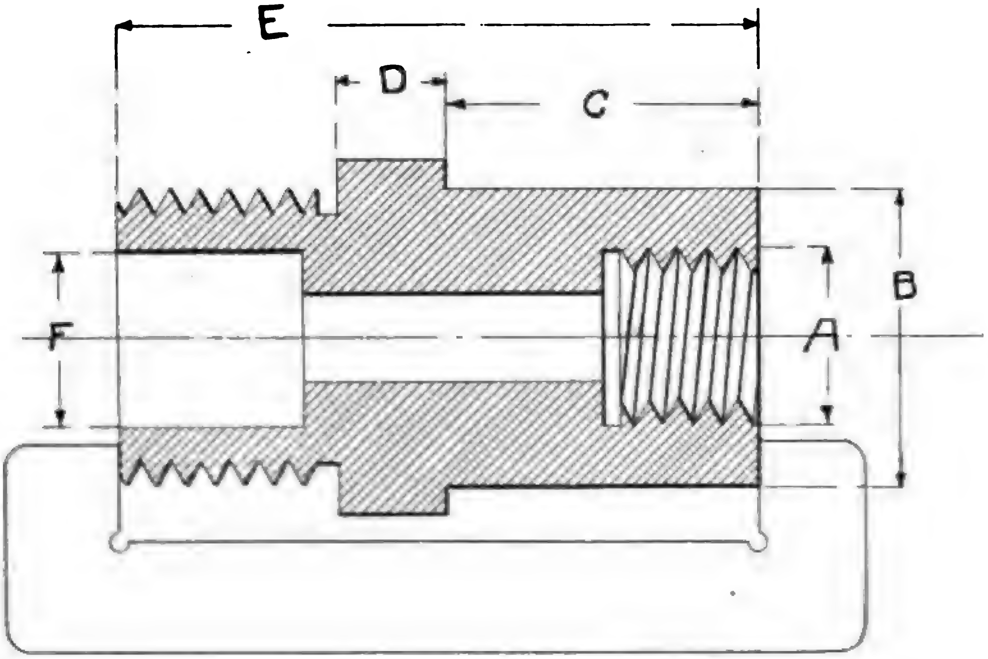


Fig. 1 Model with Gage.

has a splendid opportunity to use his inventive ability to advantage. True, a number of gauges are constructed to long established rules. Snap, plug and ring gauges are generally constructed as our grandfathers made them; but gauges for specific conditions are often designed very ingeniously.

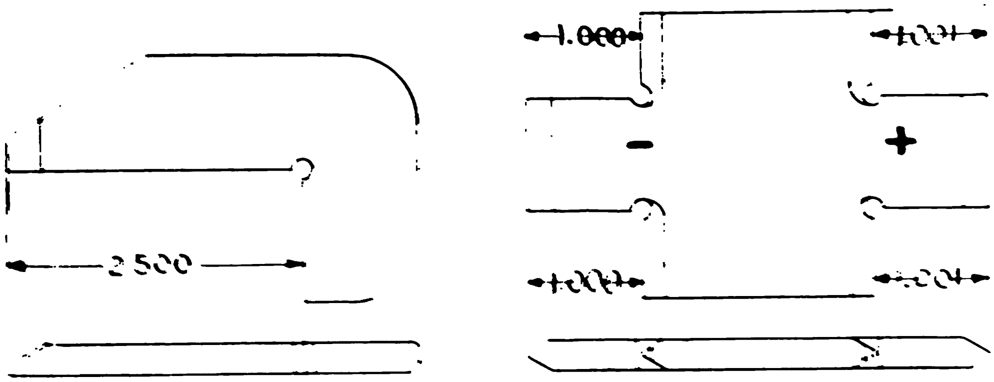
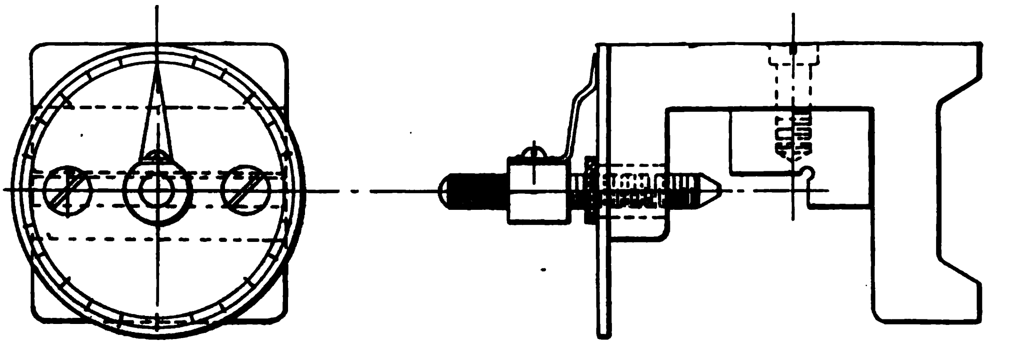


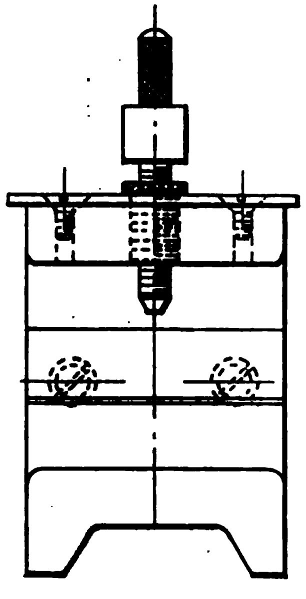
Fig. 2—Depth Gage

[illegible]

ity of illustrating and describing all classes of gauges. Some are very complicated, being actuated by electrical contact gauging points in order to get greater accuracy than is possible by human touch. A gauge of this character would comprise an article of great length, and would not be very enlightening to the reader, for its use would only cover certain conditions, and would not be used universally. We will confine ourselves to ordinary gauges, and let our ingenuity help us out when we arrive at a point where a special gauge is required.

The gauges which we are to study will give us the principle of all gauges, which is the main point in view.





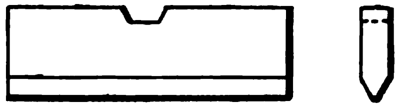


Fig. 3—Special Gage and Piece to be Measured.

LESSON V.

When designing gauges, a few important points should be borne in mind. A well-designed gauge should be light, rigid and easily manufactured. Whenever possible avoid square corners, because a square corner can not be ground; but by making clearance holes at the corners, however, there will be no difficulty in grinding. See the "depth" gauges in illlustrations; also length "gauge" in drawing of model; all of which show clearance holes. Provision should always be made for grinding the gauging points of gauges. It is sometimes necessary to construct a gauge with a number of pieces to facilitate the grinding. All gauging points should be hardened, ground and lapped to prevent wear and insure accuracy. An exception to this rule is the thread gauge, which is generally left soft, for the process of hardening is liable to distort the shape of the thread and make it inaccurate.

The simplest form of gauge is the "bar" gauge, used for determining the diameter of large holes. It consists of merely a wire or round bar of steel about 3-8 of an inch in diameter, hardened and ground rounding at the ends, the length over all is the gauging size. A gauge of this kind is not shown in the illustrations; instead, a "plug" gauge is shown, which performs the same operation a good deal more satisfactorily. Of course, the "bar" gauge has some advantages; it can be used in a deep hole, and is better than the plug gauge for very large diameters, where the plug gauge would be too heavy; but for the general run of work the plug gauge is preferable. A "ring" gauge should always accompany the plug gauge, for the purpose of testing the accuracy of the plug, and also to be used in conjunction with the plug in making fits. A "ring" gauge is shown with the drawing of the plug. (A plug gauge is used for testing the hole: a ring gauge for testing the piece to fit the hole.)

For the benefit of those who do not know how gauges are used, we have drawn a piece of work to be gauged, with letter dimensions, which correspond with the gauges shown in illustrations, and think it will make the gauging clear.

A gauge which has been the cause of serious thought is the "snap" gauge. There are three different kinds of snap gauges shown in the drawings with this lesson; an ordinary drop-forged commercial snap gauge, a "limit" snap gauge and an up-to-date limit snap gauge. The first two gauges do not require any explanation other than to refer the reader to the drawings of them, which show them quite plainly.

The "limit" gauge is used very extensively; in fact, it is adopted wherever possible, for it allows the workman a little leeway with his work, making it possible for him to feel his way

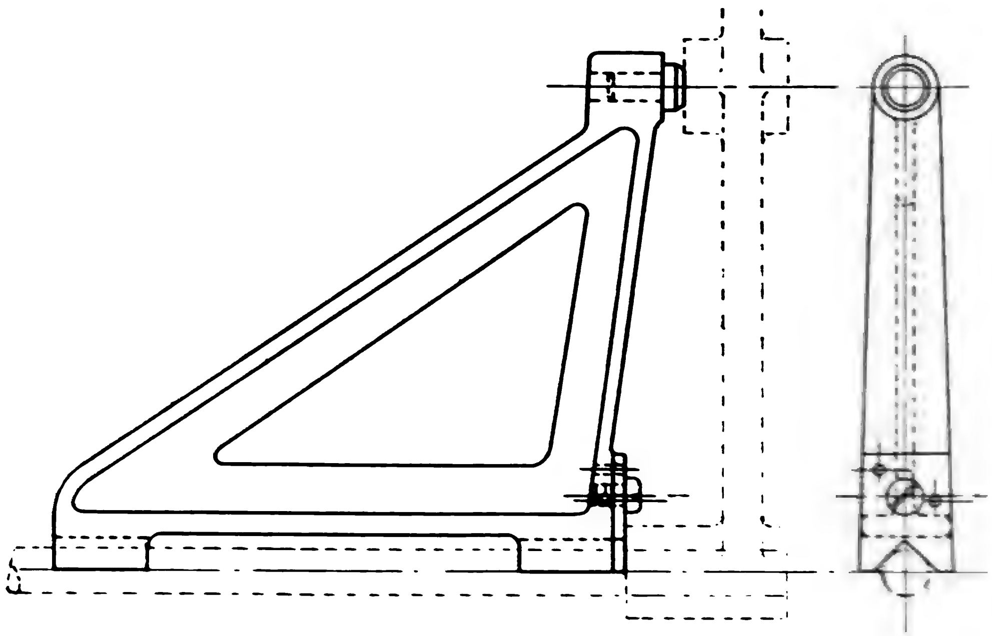


Fig. 4—Special Gage.

and to know just where he is at. By trying one side of the gauge, then the other, he can tell just how much more stock must be removed to have his work right. As a rule, a 1-2 thousandth of an inch below, and a 1-2 thousandth over the exact size, is a good limit for a snap gauge.

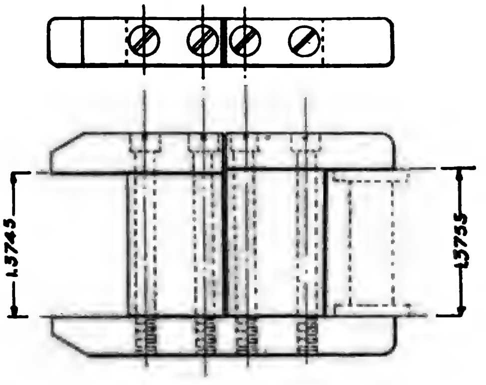


Fig. 5—Limit Gage.

Now take a look at the Modern Limit Gauge. You will observe that it is made of five separate pieces, consisting of three side pieces and two size blocks, held together by four filister head screws. You will also note that it is really two separate gauges, held to-

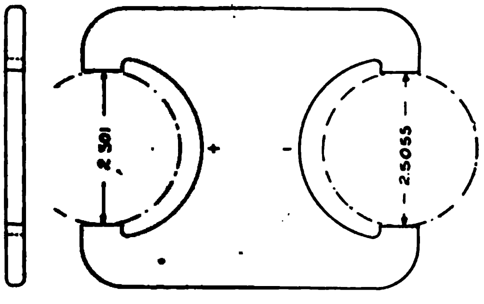


Fig. 6—Snap Gage for Diameter B.

gether by one of the sides, which acts as a gauging point for both ends.

It has been found by the experience of some of the best gauge makers that this style of construction is the proper way to build a snap gauge; although a little more expensive to make than the solid gauge, it is more accurate and easier to repair. In order to distinguish the difference between the large and small ends, or, we might say, the plus and minus ends of the gauge, the corners at the large end are made rounding, and at the smaller end beveled. (Notice this on the gauge shown.)

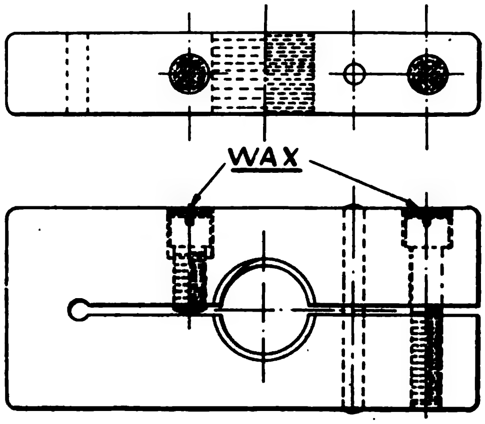


Fig. 7—Adjustable Thread Gage.

Two kind of "thread" gauges are shown; one, a solid ring gauge, with the plug to correspond; the other, the modern style of adjustable gauge. Do not misunderstand the meaning when we say "adjustable," for it is only adjusted when wear makes it inaccurate; to insure its not being tampered with, the screw-slots are filled with sealing-

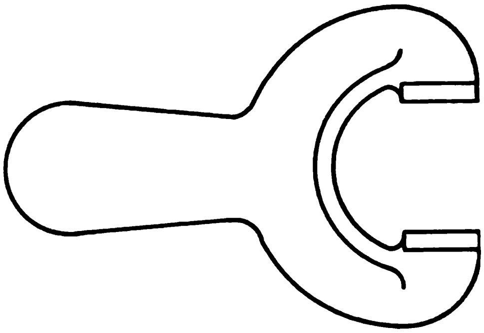


Fig. 8—Snap Gage for Diam. D.

wax; the only time it is ever adjusted is when it goes to the tool room to be set.

The other gauges are simply shown

to give an idea of the variety of forms gauges take; they really need no explanation, for the drawings show them clearly.

The gauge shown with the triangular shape is made of cast-iron, with hardened gauging-pin and block. The dotted lines show the piece being gauged. The cast-iron bracket forms a strong, yet light body for the gauge. This form of gauge is used very extensively.

When gauges have to be made to gauge very large work, they are sometimes constructed of aluminum.

A gauge we have not mentioned is the micrometer gauge. This style of gauge can be found illustrated in most any small tool catalogue.

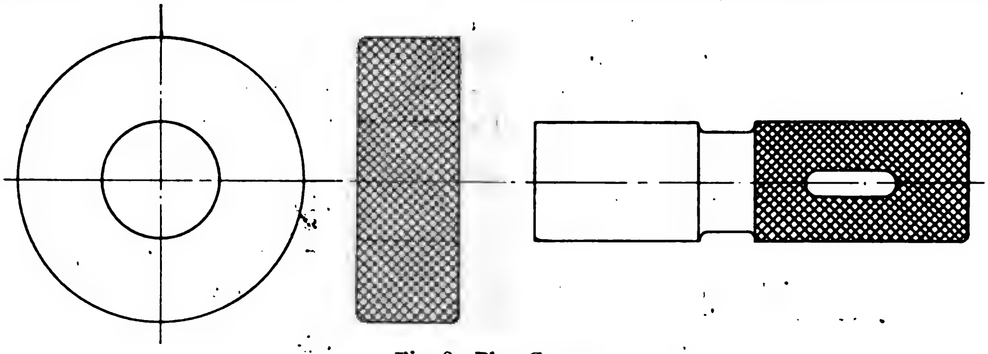


Fig. 8—Plug Gage.

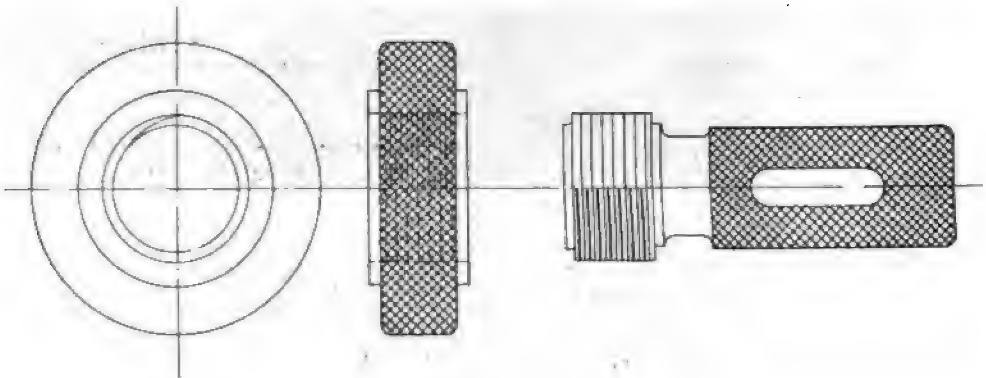
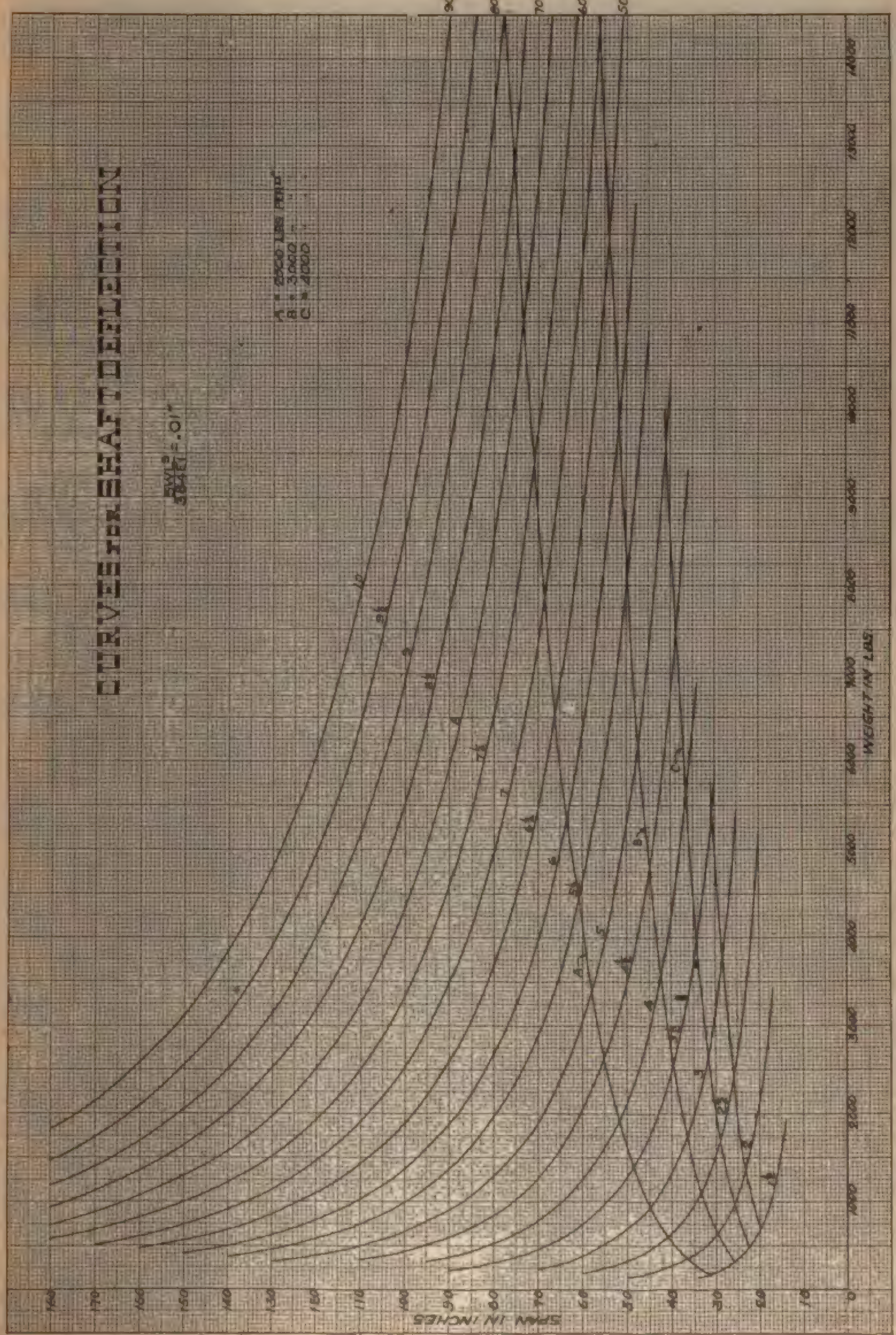


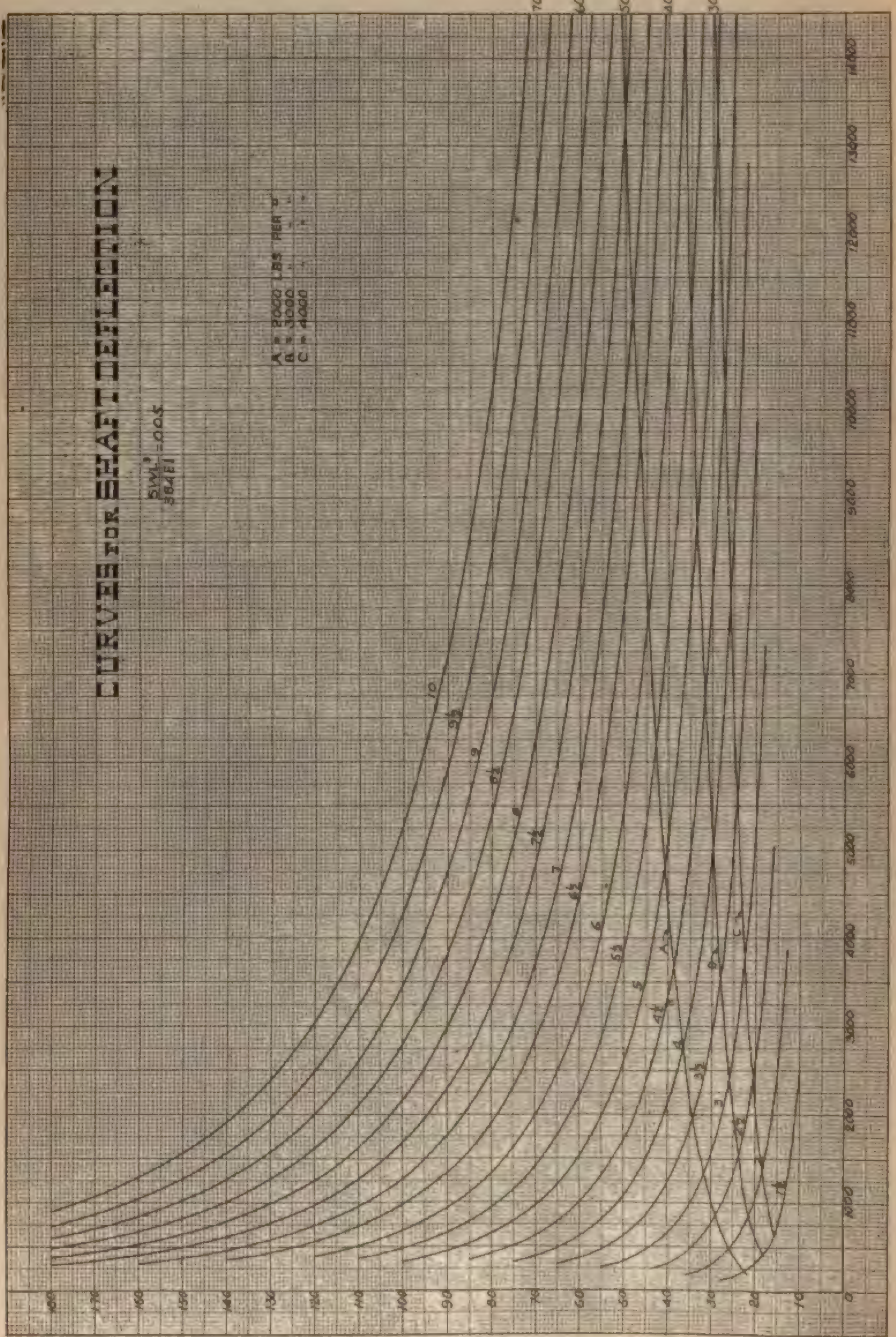
Fig. 9—Plug Thread Gage.

S. E. BOYNTON.

310 Hancock Street, Brooklyn, New York City.

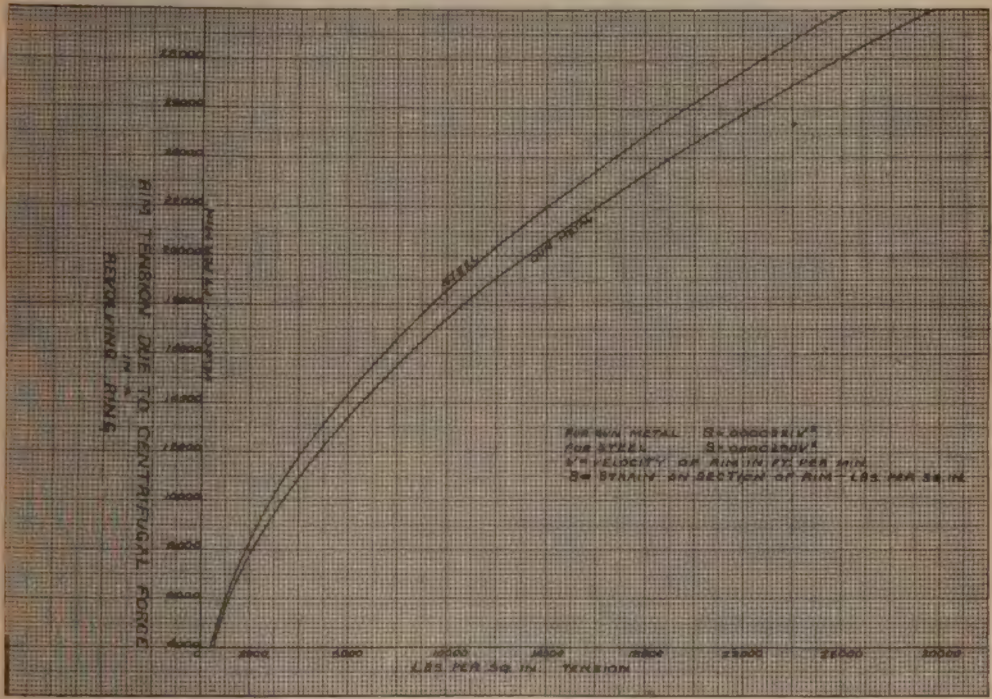
November 1, 1905.


CURVES FOR SHAFT DEFLECTION
SPAN IN INCHES
WEIGHT IN LBS


CURVES FOR SHAFT DEFLECTION
$\frac{5WL^3}{384EI} = .005$
A = 2000 LBS PER □"
B = 3000
C = 4000

Diagrams of Curves for Shaft Deflections.

This illustration and the two previous ones are diagrams of curves for shaf deflections. A very fine description of similar ones appeared in the August issue.



DRAFTING ROOM PRACTICE

Drawing Boards.

By B. R. WINSLOW.

THE necessity for more than one drawing board of the same size may not appear to the reader until he remembers several occasions when two such boards would have saved much time and probably some money. There is hardly a draftsman, especially a designer, who has not felt the need of another drawing board large enough for the work in hand, and found that his extra boards were too small.

Drawing boards are not the most expensive accessaries to the draftsman's outfit, but they are expensive enough to deter the student from purchasing more than required for his immediate needs. It is, however, quite unnecessary to purchase more boards. With a hammer and a saw and but little skill, two good boards can be made for the cost of one boughten board. The drawing shows such a board; it is not difficult to make and it will give service equal to any store board.

The size of this board is 16x24, or three inches longer than the standard board. The largest sheet of paper that can be used on the standard board of this width (16 inches) is 15x20, which allows a margin of only one-half inch all around. With this board, by fastening the paper one-half inch from the left hand side of the board, a space of three and one-half inches is obtained on the right hand side. This space will be found convenient for holding pencils and tools. Here they are under the draftsman's hand and out of the way of the twenty-one inch T-square.

Fig. 1.

Those who have to use a table that is but a trifle larger than the board will appreciate the convenience of this extra space. When the table is quite small, one or two tacks driven partly into the right hand edge of this long board will take care of the triangles.

The board proper is 16x20, with two inch strips at each end, to prevent

warping. This method of construction does away with the usual clumsy cleats on the bottom. To build two of these boards will require one piece 3-4x16x40 and one piece 3-4x2x64 well seasoned pine free from knots, and one piece 1-4x3-4x64, seasoned oak. By sawing the first piece in half, and the other pieces in four parts, sufficient material will be obtained. Having cut the pieces to the required size, they should be taken to a carpenter, who will, for a few cents, run the groove in each end to receive the oak tongue. The parts are then ready to be assembled.

First glue the oak tongue into the ends of the board, but do not let it dry. Cover the grooved edge of the cleats and also the inside of the groove with glue, fit them to the board and place in a suitable clamping device to dry.

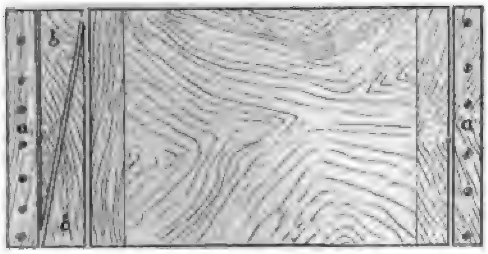


Fig. 2.

The glue to use is the kind known as "fish" or "mesh" glue; the kind with the horrible odor. Don't be stingy in applying the glue. There is no danger of getting on too much glue; the surplus will squeeze out when the clamp is applied, and can be easily scraped off when dry. But do not try to wipe it off before it dries thoroughly.

The clamping device is very easily constructed. Two pieces of wood (a, a' Fig. 2) are screwed to a table or the floor, about 28 inches apart. The board is placed against one of the pieces, a', and between the other end of the board and the other piece, a', two wedge-shaped pieces, b, b', are inserted. They are pushed together as tightly as possible with the hands, and then, with two hammers, they are driven home simultaneously.

When thoroughly dry the glue that has squeezed through the joints is removed, the worst of it with a knife and the rest by scraping with a piece of glass. Two screw-eyes in one end of the board, by which it may be hung up when not in use, completes our home-made drawing board.

Manufacturers of drawing boards dwell much upon the accuracy of their boards, which creates the impression that accurate work cannot be done on any board except those manufactured by an expert. The amateur doubts his ability to construct a board in which the bottom edge is at an "exact right angle to the working end," but this is not at all necessary. If the working end is straight all lines drawn along the T-square blade will be parallel, although they may not be parallel with the bottom of the board, and the same may be said of perpendicular lines drawn with T-square and triangles.

Electricity in the Drafting Room

By Howard S. Knowlton.

Among the conveniences which facilitate economical production in the modern drafting room electricity plays a very prominent part. The most important work of electricity in the drafting department is the illumination of drawing boards and the lighting of the room as a whole. Of late years the importance of a flexible source of light which will not in any way vitiate the air has been widely recognized, and it is safe to say that the incandescent lamp solves the problem better than any other illuminant. There is no deterior-

ation of valuable tracings and data as in gas lighted quarters; with first-class wiring the fire risk is practically nil, and the light can be carried wherever it is wanted with the utmost satisfaction. As a general rule each drafting board should be provided with a lamp and shade which can be adjusted at the pleasure of the draftsman, even though the illumination of the room as a whole may be excellent. By installing a large number of high candle power lamps in the ceiling of a drafting room, the need of individual lamps at the drawing tables may be greatly diminished, but this practice is likely to be rather expensive in comparison with the plan of providing a reasonably good general illumination throughout the room, reinforced by special lighting at the boards. There is really no need of brilliant lighting all through a drafting room—the area requiring intense light is concentrated simply at the drawing boards.

Photographic work is often carried on in the drafting department, and the installation of a dark room as an adjunct is a common practice. The incandescent lamp, fitted with a ruby or orange bulb, is far superior to the candle, oil or gas lantern, and it can be purchased in as small candle power as any commercial work requires. The ability to turn an incandescent on or off in a dark room without using a watch is a point of great convenience. Portable exploring lamps are often employed in identifying blue prints and tracings in cases, hunting for dropped articles, etc., without the slightest danger from fire. The arc light blue printing machine is an extraordinarily convenient piece of apparatus, when the number of prints to be made daily are large, and when independence of the rather fickle sun is of great commercial importance.

The fan motor is a useful contrivance in the drafting room, and its pleasing influence on hot summer days has a real value in expediting the production of work. Drafting is a close, confining task, and pure air is a vital necessity to its healthful pursuit. The fan motor has its winter uses in assisting the distribution of warm air from radiators, thawing out window panes, and at all seasons it is convenient when it is desired to dry photographic plates quickly. In very large drafting departments the small motor finds a ready use in operating dumb waiters or conveyors between the drafting room and the shop, or between the engineering and drawing office. Electric flat irons are often of great use in hastening the drying of blue prints.

No drafting room is complete without a telephone at the department head's desk, connected with the outside world as well as with the internal departments of a company's organization. Great inconvenience and loss of time almost always results from the short-sighted economy of denying the drafting department telephone service. Finally, the drafting room itself offers an excellent field for the installation of electric signals between the chief's desk and the subordinate tables or boards. Given an outfit of low-toned buzzers or miniature lamp signals, the department head can call any one of his men without breaking into the trains of thought being carried on through the rest of the department, which is no small economy in the course of a year's work.

HOWARD S. KNOWLTON,
218 Church St., Newton, Mass.

ELECTRICAL.

lpful Knowledge About Electricity.

PART IX

of the best grade, thus allowing better magnetising and demagnetising effects. Upon the core or the two legs of the magnet are placed two coils of wire, which are usually wound upon light spools and then slipped on over the iron core. These coils are wound in opposite directions so that the lines of force from each magnet will coincide, thus making the ends or poles of the magnet North and South, respectively.

The quantity of wire and the size used in their construction varies according to what the magnet is to be used for, also the amount of strength that is required in performing the necessary work.

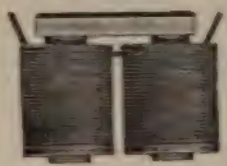


Fig. 15—Electro Magnet.

It was found that if the legs of the magnet are made of very fine insulated wire wound upon the spool, that the strength is greatly increased.

One of the most common uses to which this style of electric magnets are put is in the ordinary electric bell which may be seen in almost every house of today. The electric bell in its most simple form consists of an electro-magnet mounted upon a suitable bar. Opposite the poles is placed a pivoted armature carrying the hammer of the bell. The tension of the spring of the armature presses it against a contact screw, which is a part of the circuit of the electro-magnet. The two contact points are made of platinum, which prevents the points from corroding, and is not affected in any way by the electric spark which is carried by the armature vibrating.

When the push button is pressed, the current from the battery, which is connected in series with the push and the bell, immediately flows through the electro-magnet, then to the pivoted armature, which is pressed gently by its spring against this contact screw, from which it flows back to the battery. The instant the current passes around the coil the soft iron case becomes a strong electro-magnet, and its two poles attract the iron armature which is placed

Fig. 16—Bell Outfit (showing circuit).

opposite. The instant the armature is drawn away from the contact screw toward the magnets the path for the electric current is at once broken and the magnet immediately loses its magnetism, allowing the armature to fall back by the tension of the spring against the contact screw, whereupon the current is again closed and the armature will vibrate back and forth at a very rapid rate as long as the current is made con-

plete at the push button. The armature carries with it the metal hammer which, in its vibrating, raps against the metal gong, producing the ringing effect.

The electric bell used for call bells and in houses is almost indispensible. When two or more of the bells are needed, different toned bells are generally used in order to distinguish them. In large houses and in hotels it would be impossible to detect each individual ring by the difference in the tone of the bells alone. Thus, when a large number of circuits are required, what is known as the annunciator is used.

The size and shape of these vary according to the number of independent circuits required. In one of these instruments an electro-magnet is arranged for each circuit, and upon the closing of the circuit by the push button or some other means the magnet

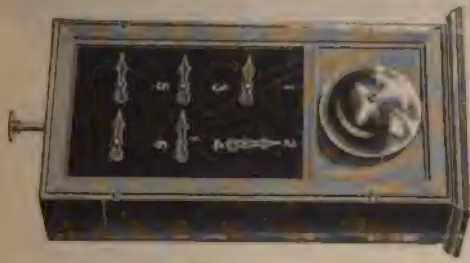


Fig. 17—Annunciator.

attracts an iron armature, which releases a little lever and allows a small pointer, which is placed upon the face of the instrument, to point, by the tension of a spring, to the given number or character.

The returning of the pointer to its original position is done by pushing in the lever which projects from the lower side of the case. In this way any number of calls may be distinguished without confusion. These instruments are of unlimited value in hotel service, doing away with a lot of unnecessary travel.

Various forms of these instruments are used by the fire department and police service, whereby the place of the alarm is immediately shown on the face or dial.

Other instruments in which the electro-magnet are very commonly used are the electric telegraph sounder and the electric relay.

Joseph Henry was practically the first to use the electro-magnet for telegraphic purposes. In 1831 he constructed in rather a crude form what we may call the first electric magnetic telegraph.

The telegraph sounder as we know it at the present time was greatly improved and perfected by Samuel Finley Breede Morse. Morse was in all senses of the word an American genius, being born at the foot of Breed's Hill, Charlestown, Mass., on April 27th, 1791. It was not, however, until 1832, while on his way homeward from England, that he began to dream of the wonderful possibilities whereby messages could be sent along a wire by the aid of the electric current. His first successfully working instrument was made in the year 1836, and from that time on the instrument has been rapidly developed to what we know it today.

It will not be necessary, however, in this article to go further into detail with the development of the telegraph and the adoption of its use throughout the country. (For a better and more accurate account see "Wire and Wireless Telegraphy," by Moore.)

A telegraph sounder as used today may be seen in one of the accompanying illustrations.

It consists of a pair of strong electro-magnets mounted upon a metal bar.

These magnets are usually well constructed and are protected from outside injury by a hard rubber shell, which is

drawn on each individual coil.

Mounted directly over the poles of these two magnets is a soft iron armature, which is attached to a pivoted brass lever and is allowed to move freely, one end moving between two adjustable set screws, from which the click of the instrument is made.

A small spiral spring is attached to the opposite end of the lever, which draws it against the upper screw whenever the current is interrupted.

Sending the electric current with the interruptions through he line upon which the sounder is connected will cause the lever to move up and down between the two set screws. Different movements and combinations of these movements represent different letters of the alphabet.

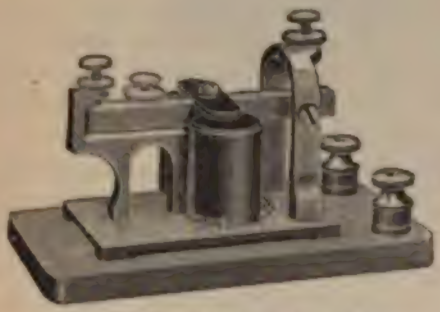


Fig. 18—Electric Telegraph Sounder

The special spring on the lever of the sounder may be adjusted according to the strength of the electric current passing through the line.

The ordinary telegraph sounder requires a comparatively strong electric current sufficiently strong to operate it so as to make the dots and dashes easily distinguishable.

One can readily see that upon long commercial lines where a large number of instruments are necessary that quite a strong current is necessary to obtain the desired results.

The reader has previously had explained to him that Henry found upon using a large amount of very fine wire the lines of force were greatly increased, therefore producing greater magnetic effects. Also when very fine wire was used a very weak current produced quite an effect upon the core, otherwise it would scarcely be affected.

Now instead of mounting a heavy armature and lever opposite the poles of these so constructed magnets, we will place a very light, delicate lever and armature. The spring used is also very sensitive.

This lever is mounted perpendicular to the bar of the instrument and the upper end is allowed to move between two adjustable screws. The distance between these screws is very small and the movement of the lever is thereby greatly reduced.

The electro-magnets or coils of this instrument are connected upon the main lines through which the feeble electric current passes, and as before explained, operate the very light armature and lever. It would be almost impossible to detect the dots and dashes from the nearly noiseless movement of this lever, so the screw upon which the lever is presses against by the tension of the spring is insulated from the lever itself, and what is called the local battery is connected with the lever and the other screw, which completes the circuit. This local battery consists of a strong battery, not connected upon the main line in any way. Connected in series is an ordinary telegraph sounder having a heavy lever, as before described, from which the signals are distinctly determined.

When the intermittent current is sent through the main line by the operation of the key, which is connected in series with same, the very weak cur-

rent passes around the very fine wire upon the magnets, causing the armature or the light lever to attract. When the lever is attracted an electrical contact is made with the uninsulated screw and in this way acts as a sort of a switch, opening and closing the local or strong circuit, which in turn operates the sounder from which the signals are determined.

This instrument which is used to introduce a strong current into a local circuit, independent of the main line, and which in turn is made to operate much coarser instruments from which the messages are taken, is called a re-

Fig. 19—Electric Telegraph Relay.

lay. It is supposed that Edward Davy, a great scientist, was the originator of the perfected relay, although Joseph Henry was the first to construct a delicate instrument whereby very fine insulated wire was used in large quantities.

One cannot easily estimate the real value of the electric magnet in all branches of electrical work. We have in this chapter only given a brief account of some of the principal uses: those which we are constantly using in our every day life. There are, however, a thousand and one more ways in which the electric magnet may be employed.

We are, in this twentieth century, living in a world of electrical marvels and discoveries. Hardly a day passes but what some new discovery brings to light the vast and unlimited future of the electrical field, which waits in store for the men who, after almost endless researches and with determined perseverence, bring to the world's notice the wonderful possibilities of the future and the simplicity of the things of the past.

The next chapter will be intensely interesting, wherein we will try to place before our readers, in as simple language as possible, one of the most wonderful and perhaps unexplainable porperties of electricity, viz., electrical induction.

I would advise all to carefully and intelligently follow it, because the foundation of many of the electrical machines and instruments which are in the front rank today are based upon its laws and actions. If the reader obtains a good practical understanding at the start many of the now wonderful and almost unaccountable phenomenas will be made plain, simple and clear.

(To Be Continued.)

HOME STUDY.

Hydrostatics.

(Continued.)

By C. C. Mason, E. E.

IF a piece of glass tubing of very small bore be placed in water, the water will rise in the tube above its outside surface against the force of gravity. Upon withdrawing the tube it will be found that the water has wet the surface of the tube. If the tube be placed in mercury, this liquid within the tube will be depressed below the outside surface. If the tube be withdrawn, it will be seen that the mercury did not wet the glass. It is found to be true that all liquids that wet the surface of solids placed within them will be lifted, while those that do not will be depressed. Archimedes' principle shows that when a solid is immersed in a liquid, it displaces a volume of liquid equal to itself. The pressure on all sides of the immersed body is proportional to the depth. The lateral pressures being exerted on the surface at the same depth are equal and balance each other. The vertical pressures on the top and bottom are unequal, because of the fact that these surfaces are at unequal depths.

The upward pressure on the bottom exceeds the downward pressure on the top and causes a body to lose a portion of its weight. In Fig. 1 is shown a cube immersed in water. The face a, b is being forced upward and is the weight of a column of liquid whose area is that of this face, and whose height is the depth of the face below the surface. Hence the upward pressure is equal to a column of water e, f, a, b. The downward pressure exerted on the surface a, b, is the weight of the column e, f, a, d. The unbalanced upward pressure is (E, F, a, b)—(E, F, c, d)=c, d, a, b. We suppose this cube in Fig. 1 to be four inches on a side and is suspended in the water so that its sides are vertical and its upper surface four feet below the surface of the water. Then we have:—Cube=4" on a side=4x4x4=64 cu. inches.

1,728 cubic inches=1 cu. foot.

Iron weighs 480 lbs. per cubic foot. Supposing the cube to be iron, then we find the weight W from the proportion:

$$1{,}728 : 480 :: 64 : W$$

$$W = \frac{480 \times 64}{1728}$$

This cube is pressed down by a column of water 4 inches square and 4 feet high or 1-3x1-3x4=4-9 cubic feet, therefore the weight is obtained from the proportion, but referring to floating bodies we find that the weight of a body may be less, equal to or greater than the weight of the liquid it displaces.

This also is "Archimedes' Principle." We saw in the first instance that the upward pressure was greater than the downward on the immersed body, therefore the body will rise to the surface of the liquid and float thereon. In the second instance, all forces acting on a body balance one another, and thirdly, the resultant of the upward and downward forces is downward, and therefore the body sinks. To prove this, a piece of fine cedar or any other like timber having a volume of one cubic inch is immersed in water. It will displace one inch of water, which weighs .03616 lb. The

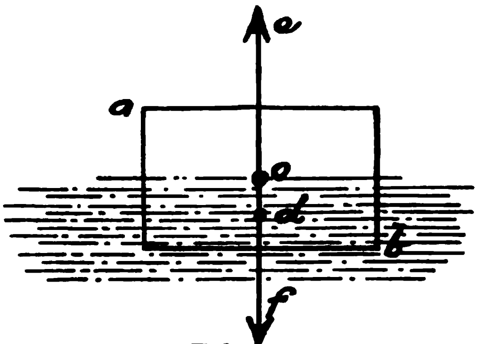


Fig. 1.

weight of a cubic inch of pine is .02109 lb. Then the upward pressure exceeds the downward by .03616—.02109= .01507 lb. The pine rises to the surface and a portion remains submerged, which will displace .02109 pound of water. However, if we took a piece of marble and immersed it in water it would sink. The weight of marble is taken at .10415 pound per cubic inch thus: .10415—.03616, and the marble will sink because it is heavier than water. But bodies are made to float even though they may be several times as heavy as water. For instance, we see iron and steel in the shape of large ships floating. This is by giving these metals their proper shape, so that the weight of water displaced is heavier than the metal, and again we have floats to regulate the height of water and so operate the discharge of steam traps, are usually made of metal. This proves more conclusive that metals float if given the proper shape.

A body is in equilibrium with respect to movement of the entire body, that is, when all the forces acting upon it equal zero, but for complete equilibrium however, the two equal and opposite forces must act along the same line, as per figure 2. A, B is a block of

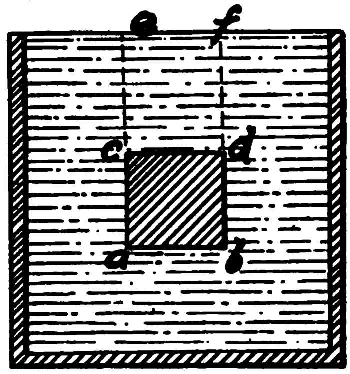


Fig. 2.

wood floating in water. O is the center of the wood, and the resultant of all the forces downward, due to its weight, is represented by O,e, F, is the center of buoyancy, and the resultant of all the upward forces is d, e; thus if the block is in stable equilibrium if the action of the couple is to restore it to its original position, and in unstable equilibrium, if the couple causes it to depart more and more from its original position. The standard for solids and liquids is distilled water whose temperature at 39.2° F., and for gases, air or hydrogen at 32° F. We find the specific gravity of a body thus. If the body whose specific gravity is to be

found is heavier than water, then its weight W in air is first obtained, when it is after suspended in water and its weight W obtained, and this rule stands good in thus. The specific gravity of a body is its weight in air divided by the loss of weight in water, and we apply this formula for such a case:

$$\text{Sp. Gr.} = \frac{W}{W - W'}$$

But in another case we have where the body is lighter than water. To find the specific gravity weigh both bodies in the air and in water to get the loss of weight in water. The loss of weight of the heavy body is obtained in the same manner. Both bodies and the weight of the body is subtracted from the loss of weight of both bodies, and the weight of the body whose specific gravity is to be obtained is divided by the difference. While the specific gravity of a liquid may also be found by using a flask of a known weight graduated to hold a certain quantity of liquid. The flask is filled with water, then some other liquid and both weighed. The weight of the liquid, divided by that of the water, gives the required answer, which will be the specific gravity.

A Problem.

Draw them without taking the pen of the paper, and with the least amount of retracing

STRUCTURAL.

Formulae for Hip and Valley Angles in Roof Work.

By [illegible]

NORMAL PURLINS

[illegible]

Then —

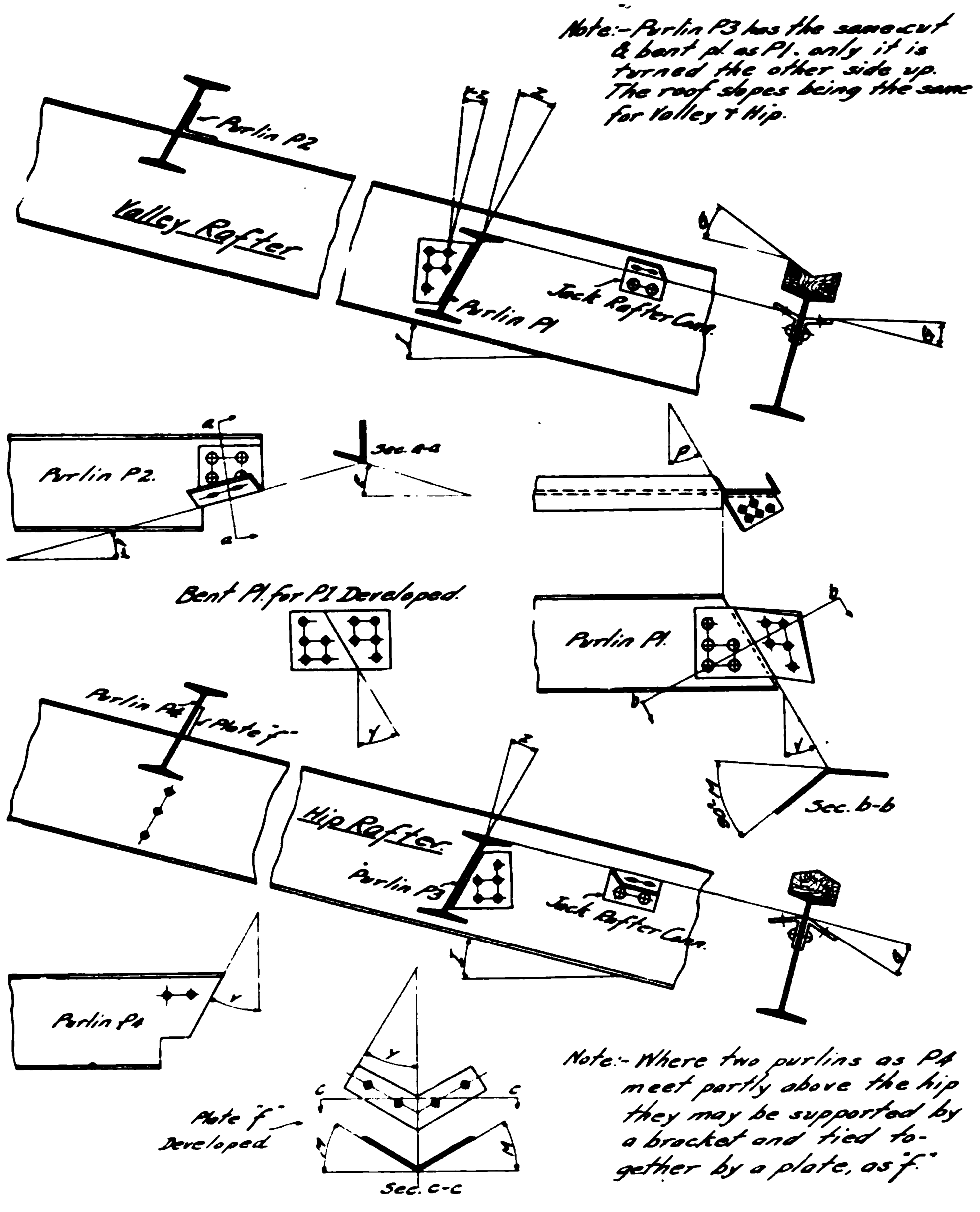
[illegible]

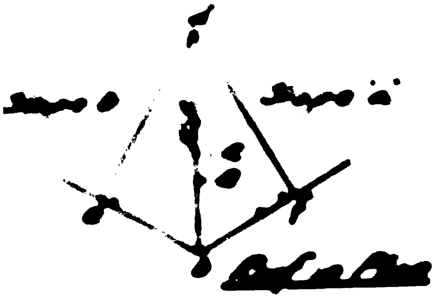
2a.—Tan. P.=cos. a.
3a.—Tan. V.=sin. a.
4a.—Tan. G.=sin. I.
7a.—Tan. M.=cos. X.

Now when the two roof planes do not have the same slope or when they not only have different slopes but their lines of intersection with a hor. plane form any ∠ different from 90° (which we will term C), before we can apply the fore-

ANGLES IN HIP & VALLEY ROOF WORK.

PURLINS NORMAL TO ROOF.





CURRENT TOPICS.

WITH THIS number we close our fourth volume and the index is included in this issue. The January issue will carry some changes and improvements.

THE YEAR 1906 should be noted for an organization of draftsmen in some form or other. There has been much said, much more can be said on tne subject. Perhaps something may be said in our next issue of the "Societies that have failed."

ANY DESIGNER interested in hoisting and conveying machinery should read an announcement on the inside page of front and back cover. The new magazine will be the same size as THE DRAFTSMAN and be issued in January.

THERE HAS been some enquiry in regard to sending THE DRAFTSMAN during the life of the subscriber for $10.00. This enquirer said he would willingly send that price if he could be puf on the list for life. We hope to be running this magazine at least 25 years and will accept the offer, for if we are not here someone else will do it. Send in a ten dollar bill or money order at once.

Now Grab !

I think that the profession is aroused to some extent, and I hope the time is not far distant when we brother "Pencil Pushers" will organize.

There used to be a story in one of the readers that told of a man who went to look at a piece of land he had bought. In order to get a better view of the place than he could from the ground, he climbed to the top of a tall stub of a tree. When he reached the top he found that the stub was hollow. His foothold giving away he fell inside, clear to the bottom. He must have had some interesting thoughts on the way down, but these were as nothing compared with his feelings when he found a bear lying curled up down there. The man's sudden appearance frightened the bear terribly, and with a grand lunge he sprang up and started for the top.

"Now is my chance!" thought the man, and he grabbed the bear by the whiskers on the sides of his hams as he bounded out of the hollow, and the animal quickly whisked him out of his perilous predicament.

I have always had a great deal of respect for that man. He saw his chance and made a grab for it; that was sensible.

Now brothers let us get together; of course, it is nearing the holidays, and no doubt some are saving up their pennies for nice things and a good time, but I think we should be like that man,—grab the opportunity and hold a meeting, say some time in February, at Cleveland. Who will meet me there; what do you say?

Yours respectfully,

A. B. HAYES.

Ed. Draftsman.

Dear Sir—Your contemporary, Mr. A. B. Hayes, of Milwaukee, in his pro-

posed by-laws for the formation of a (as he terms it) Operative Draftsman's League, in Article II, Sec. 1, states that all applicants should be white American-born or naturalized citizens. I would like Mr. Hayes to understand that this is an era of enlightenment and possibilities. Why should not a colored man be a member of the league? There are in this country colored draftsmen who are in every respect practicable and very enterprising and gentlemanly. The writer has worked with colored men and has found them very applicable, and there should be no reason why they should not be allowed to join such an association. I presume, Mr. Editor, Mr. Hayes must be connected with some political party, and possibly may take a personal interest in politics; if so, he must understand that the vote of the colored man is equal with that of the white man when electing officers for the highest positions in the country, and consequently he possesses the right to become a member of this association and benefit thereby. LINCOLNITE.

Cleveland, O., Nov. 11th, 1905.

Civil Service Examinations.

The U. S. Civil Service Commission announces an examination on Dec. 13-14, 1905, to secure eligibles to fill vacancies which may occur in the position of topographic draftsman in any branch of the service.

The Commission also announces an examination on January 3, 1906, to secure eligibles to fill a vacancy in the position of electrician, at $1,000 per annum in the Quartermaster's Dept., Washington, and vacancies as they may occur in any branch of the service requiring similar qualifications.

Applicants should address the U. S. Civil Service Commission, Washington, D. C. for blanks and information.

Book Reviews

"Modern Locomotive Engineering," hand-book, by C. F. Swingle, M. E.

Pocket book style, full seal leather with gold stampings and edges. Price, $3.00. Frederick J. Drake & Co., 211 E. Madison street, Chicago, Ill., are the publishers.

The aim of the author in compiling this work was to furnish to locomotive engineers and firemen, in a clear and concise manner, such information as will thoroughly equip them for the responsibilities of their calling. The subject matter is arranged in such a manner that the fireman just entering upon his apprenticeship may, by beginning with Chapter I, learn of his duties as fireman, and then by closely following the make-up of the book in the succeeding pages, will be able to gain a thorough knowledge of the construction, maintenance and operation of all kinds of engines.

Breakdown, and what to do in cases of emergency, are given a conspicuous place in the book, including engine-running and all its varied details. Particular attention is also paid to the air brake, including all new and improved devices devices for the safe handling of trains.

The book contains over 600 pages, and is beautifully illustrated with line drawings and half-tone engravings. Plain, simple and explicit language is used throughout the book, making it unquestionably the most modern treatise on this subject in print.

No writer of modern times is as well posted in the matters pertaining to the

building trades as Mr. Fred. T. Hodgson, author of many books on these subjects. The latest is "The Twentieth Century Bricklayers' and Masons' Assistant," a book of over 300 pages written in the plain, progressive manner characteristic of the author. It is an exhaustive treatise on all kinds of bricklayers' and masons' work, including foundations, bonding, arches, chimneys, piers, bridges, &c. To borrow an expression, "it's written so you can understand it." Published by Frederick J. Drake & Co., 211 E. Madison street, Chicago, Ill.

No book on physics has come to our notice that contains as much practical every-day matter as the one written by Messrs. Mann and Twiss. It contains 450 pages, eight full page plates, 238 illustrations, a full index and an analytical table of contents. The aim is to give the student such a knowledge of physics as will enable him to understand many things that surround him in nature. The illustrations are fine, many being taken from photographs. It is a splendid book for self study, and anyone desiring such help will do well to secure it. Price, $1.25. Scott, Foresman & Co., Chicago, Ill.

"Mechanical Machinists' Tools" is a sub-title to a neat catalog recently issued by the Brown & Sharpe Mfg. Co., Providence, R. I., the pages of which are covered with illustrations of high-grade machinists' tools manufactured by this firm. There are also a number of pages devoted to instruments used by draftsmen and patternmakers. The business now conducted by the Brown and Sharpe Mfg. Co. was founded by in 1833 by David Brown and his son, Joseph R. Brown. David Brown retired in 1841, and the business was continued by the son until 1853, when Lucien Sharpe became his partner, and the firm name became J. R. Brown & Sharpe. The manufacture of steel rules and other tools of precision was begun by Joseph R. Brown in 1850, and in 1852 Samuel Darling began a similar line of work. The partnership of Darling, Brown & Sharpe was formed in 1866, and the business carried on under that name until within a few years, when the partnership was dissolved by the purchase of Mr. Darling's interest. The floor space in 1853 was 1,800 sq. ft., while at the present day it is 513,775 sq. ft., or about 12 acres.

New Inventions.

The following inventions have been specially reported for The Draftsman by C. LeRoy Parker, Solicitor of Patents, 707 G street, N. W., Washington, D. C.:

POCKET CALCULATOR.

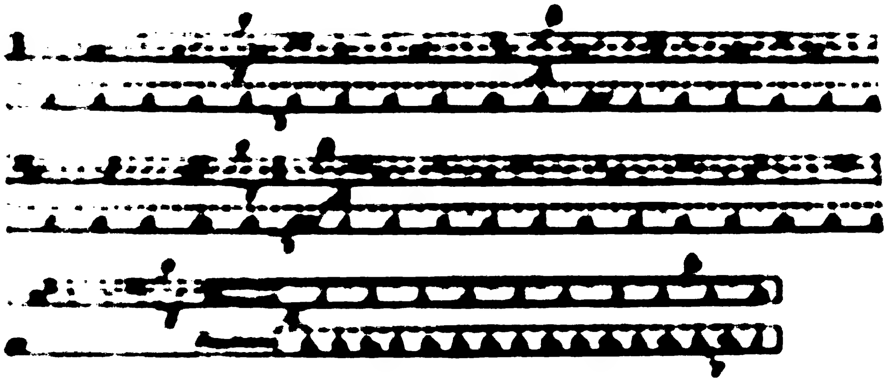
No. 801,354—Franklin S. Beckett; October 10, 1905.

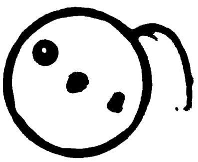
This invention is a calculating chart in the form of a pocket tape designed for computing, multiplying, dividing, ascertaining the roots and powers of numbers, etc.

The object of my invention is to provide a simple, compact, handy device for calculating mathematical problems and which may be readily carried in the vest pocket.

Since every decimal has its corresponding equivalent fraction, the notation on scale 6 bears a certain definite relation to that on scale 7, so that if it is desired to find the equivalent fraction of any decimal it is only necessary to find that decimal on scale 6. Turn over the tape and the fraction on scale 7 directly opposite the decimal just indicated will give the desired result. For instance, to find the equivalent fraction of .8125. Solution: Find ".8125" on

[illegible]





[illegible]

To find the power of a number … [illegible]

[illegible]

The illustrations show a top plan view and a front elevation of the apparatus.

The whole device is mounted on a board, such as indicated at A, and having a flat surface upon which the sheet to bed marked may be placed and clamped in proper relation to the marking tool. The marker controlling mechanism is mounted in a frame B, of a somewhat irregular diamond shape and having downwardly extend-

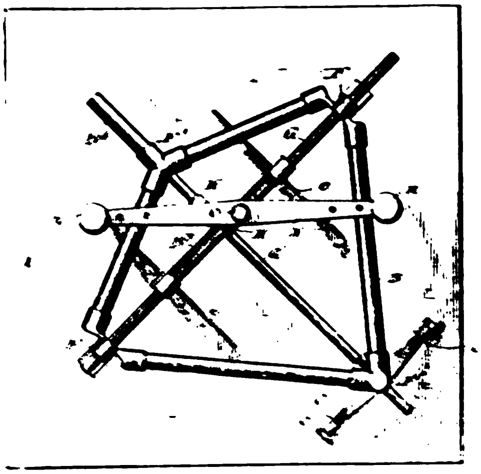
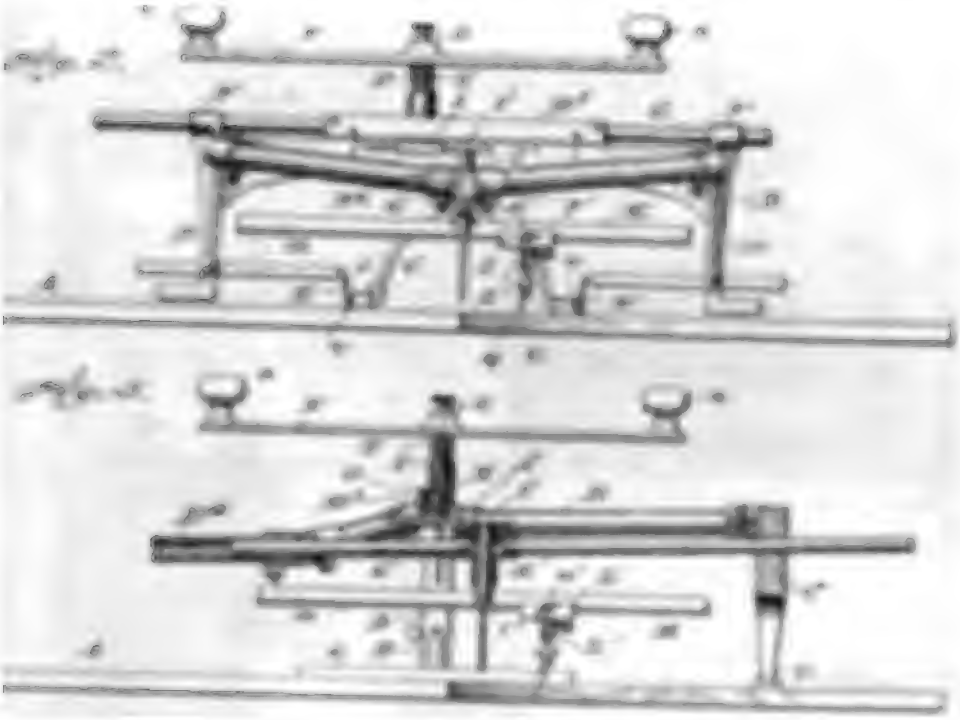


Fig. 1.

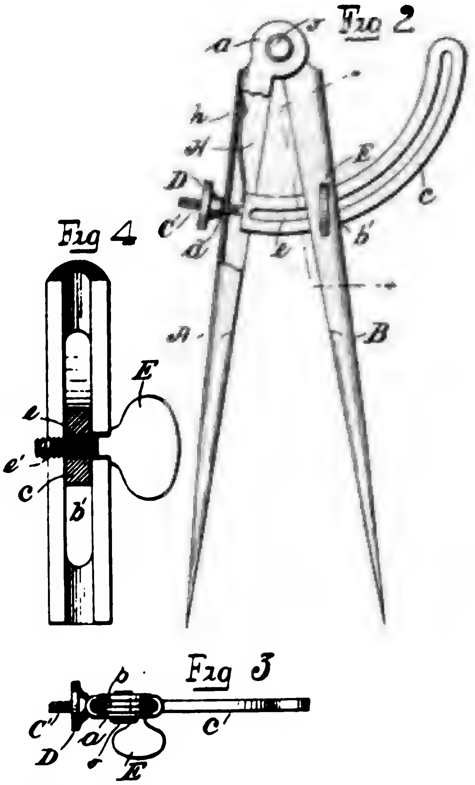
ing legs at three corners, the leg C at the rear corner being bifurcated and the branches pivotally connected at C with the table or support A, thereby permitting the frame to be swung up out of the way or brought down into parallelism with the table. The legs DD at the other two corners have adjusting clamping feet EE, with clamping edges e e elongated from front to rear or in the direction of the greatest diameter of the figure to be marked, and clamping edges being adapted to rest [illegible] the sides [illegible] board to hold it [illegible] place.

[illegible] bearings FF are formed [illegible] corners [illegible] frame for the reception of horizontal sliding shafts G and G, said shafts being arranged to move in lines exactly at right angles to each other, one shaft, however, being located in a plane somewhat below the other. Each shaft is provided with a central boss, forming vertical bearings for vertical shafts I and I adapted to both rotate and slide vertically in the bearings. The shaft I carries at its lower end a slide i, through which a crank-arm i' on the upper end of the shaft I' may be adjusted, so as to vary the length of the crank connection, and consequently the relative displacement of the two horizontal shafts G G'. The lower end of the vertical shaft I' is provided with a support for the marker carriage L, said support being in the form of a crank arm M, extending on opposite sides of the shaft and parallel with the crank-arm i on the upper end of the shaft. The arm M forms the carriage support and has guideways m thereon for the carriage L. The carriage may be clamped in adjusted position by a set screw m'. The upper end of the shaft I is provided with an operating handle N, extended on both sides of the shaft and provided with adjustable knob handpieces n, by which the two shafts I I' and the marker carriage may be rotated. The path described by the marker depends upon the length of the crank i and the adjustment of the carriage on the carrier M, and both of these parts are provided with graduations to indicate the adjustment. The adjustment of the crank i is maintained by a set screw O, extending axially of the shaft I, its head being located above the operating handle and serving in part to retain the latter in place.

The vertical movement of the shafts I I' and connected parts is for the purpose of advancing the marker toward or withdrawing it from the surface of the mat, and the parts are held up by



the arc-shaped wing C to pass through the slot thus made. The sides of the leg B are locked upon the wing C by means of the thumb screw E, which passes through one of the sides of the leg, through the slot e in the wing C, and by means of a screw thread e' is adapted to enter the other side of the leg and engage the screw thread therein. The sides of the leg B being flexible, the legs are readily locked in any



position by tightening the thumb screw, and thus causing the sides of the leg B to grip the wing C. Housed in the leg A and bearing on the inner side of the leg and the end of the wing C is a flat spring H, which forces the wing as far from the legs as the nut D on the screw C'' will permit. The leg B having been locked upon the wing C, a nice adjustment at any angle may be obtained by turning the thumb nut D on the screw C against the tension of the spring H.

BEVEL SQUARE.

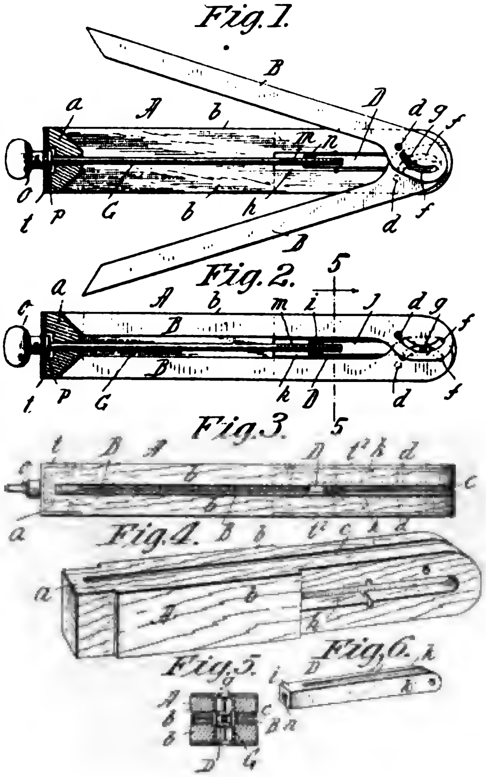
No. 802,083—Charles B. Parnell; October 17, 1905.

This invention relates to improvements in bevel squares of the kind having a stock or a main bar and one or more blades pivotally connected to the main bar and adjustable relatively thereto at any angle.

The object of the invention is to provide an improved device for moving and locking the blade.

In the illustration A represents the stock, which is split longitudinally from one end nearly to the other end, the latter end having, however, the solid portion a uniting the upper and lower portions b b of the stock, the opening c between the members b b being sufficiently wide for accommodating and permitting free movements of the blades B B, which are made flat and of thin metal and are pivoted at d d to the upper and lower separated members b b of the stock. The blades have in their end portions adjacent their pivots the cam slots f f, in both of which a single stud g engages, said stud being carried by a split slide block D, which is accommodated in a longitudinal slideway or opening h, made in both members b b of the stock. This slide block B, formed bifurcated and having the solid end portion i, has the opening j between its legs k about as wide as the opening c in the stock and to give sufficient space for accommodation therewithin of the thin metallic blades B B at the opposite end portions thereof. The longitudinal movement of the slide block D causes swinging movements of both blades by reason of the engagement of the stud g in the cam slots f, and the means for moving

the slide block endwise is found in the rod G, which is extended longitudinally and centrally within the stock, being rotatable relatively to the latter, but incapable of endwise movement relatively thereto, the inner extremity of said rod, which is screw-threaded, as repre-



sented at m, screw-engaging in the solid part of the slide block. The operating rod G is provided at its end adjoining the solid end of the stock with a handle or thumb knob o. The collar p, formed on the rod, by its abutment against the metallic trimming t prevents the outward movement of the rod, while the thumb piece o acts as a shoulder to prevent any inward movement.

PROTRACTOR.

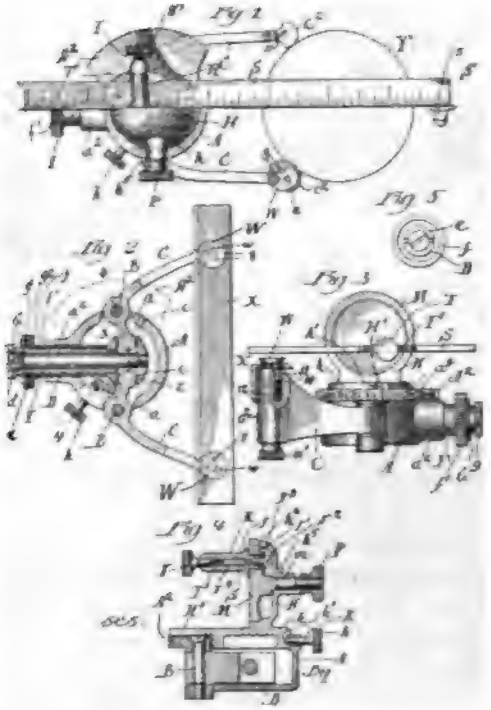
No. 802,674—Abraham Anderson; October 24, 1905.

This invention has for its object to provide an improved instrument whereby angles, lines, etc., may be laid down on plane, curved, regular or irregular surfaces.

The illustrations show a plan view of the protractor and also a view in horizontal section.

The body A of the protractor comprises a chambered casing, in one side of which are formed openings a, and opposite these openings a are mounted studs B, whereon are pivotally supported the gage arms C. The inner ends c of the gage arms C are preferably rounded, as shown, and set between the heads 2 and 3 within the casing A. The head 2 is screw-threaded firmly to the reduced inner end of a rod D, that extends in manner free to slide a sleeve E, that is revolubly held within an outer sleeve F, that passes from the inside to the outside of the casing A, the periphery of the sleeve F being screw-threaded to engage corresponding threads formed upon the interior of a boss a^2 projecting from one side of the casing A. The outer end of the clamping rod D is formed with an expanded screw-threaded portion d, that sets over the outer end of the sleeve E, and the outer end of this sleeve E is provided with an outwardly projecting annular flange e that overlaps the outer end of the outermost sleeve F. The sleeve E is revolubly sustained within the sleeve F, but is held against longitudinal movement with respect thereto by the flange e at its outer end and by head 3, that is screw-threaded to its inner end. Upon the outer threaded end portion d of the rod D is fitted the interiorly-threaded nut lock G. This lock nut G is formed with a milled rim g, whereby the nut may be turned, and is formed also with an angular flange g′, having an inwardly extending annular rim g^2,

that is slightly deeper than the flange e at the outer end of the sleeve E and is adapted to bear against the expanded



cup-shaped open end f of the sleeve F, as shown in the illustration. This cup-shaped outer end f of the sleeve F is milled upon its periphery as at f', so as to permit the sleeve F to be readily turned by the thumb and forefinger. By turning the sleeve F through the medium of its milled outer end f', the sleeve F can be moved inward or outward, carrying with it the sleeve E, the rod D and the heads 2 and 3, between which extend the inner ends of the pivoted arms or levers C. This inner and outer movement of the sleeve F will effect a corresponding movement of the arms C about their pivot studs C, and when the arms C are thus moved to any desired extent they may be fixed against further movement by turning the lock nut G. A set screw K, having a milled end k', passes through a threaded hole in the casing A, and the inner end of the screw K enters the annular groove h' and serves to hold the base h of the standard H in place within the top of the casing A. By loosening the screw K the mount or disk h can be rotated on its vertical axis, and by tightening the screw K the base h can be fixed at any desired position with respect to the casing A.

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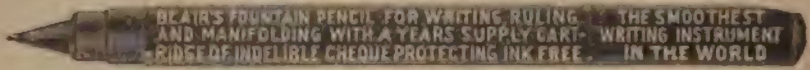

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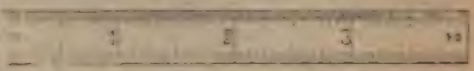

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